The Engineer

LONDON, FRIDAY, NOVEMBER 21, 1941

PUBLIC NOTICES

NORTH WELLAND INTERNAL DRAINAGE BOARD

TENDERS INVITED FOR THE SUPPLY AND ERECTION OF PUMPING PLANT

The Above Board Invites TENDERS for the SUPPLY and ERECTION of PUMPING PLANT for the drainage of approximately 600 acres of land in the Fen Area. Inspection of the site may be made, and full particulars obtained from the undersigned on application in writing. Tenders, in a plain sealed envelope, bearing no name or mark indicating the identity of the sender, endorsed "Pumping Plant," must be received by the Clerk of the North Welland Internal Drainage Board, 11, Market Place, Spalding, not later than Friday, 28th November.

The Board does not bind itself to accept the lowest or any Tender and the acceptance of any Tender is subject to the approval of the Ministry of Agriculture and Fisheries.

N. W. HAMPSON, Assoc. Ms Inst. C.E.,
Engineer to the Board.

Station Street,
Spalding. 7923

LEICESTERSHIRE EDUCATION COMMITTEE

MELTON MOWBRAY & DISTRICT COUNTY TECHNICAL COLLEGE

Required, a Fully Trained ENGINEER to Superintend Engineering Instructors and to Take Charge of Well-equipped Workshops and Engineering Laboratories. Salary £ per annum. Applications, with three recent testimonials, should be sent to the undersigned not later than 24th November, 1941.

W. A. BROCKINGTON,
Director of Education.

County Education Offices,
Grey Friars, Leicester. 7913

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

RESTRICTION ON ENGAGEMENT ORDER

CHIEF CHEMIST for Important Birmingham firm of Automobile Equipment Manufacturers, engaged entirely on war work; essential qualifications and good knowledge Ferrous and Non-ferrous Metallurgy and experience of co-operating with works in dealing with troubles. Permanent position.—Box No. 398, 19-21, Corporation Street, Birmingham, 2. 7953 A

CONTRACTORS' AGENT REQUIRED for provinces by London Firm. Only men capable of taking full charge of large constructional contracts considered.—Address, stating full experience, salary required and when free to commence, 7939, The Engineer Office. 7939 A

ENGINEERING MANAGER REQUIRED, with first-class Machine Tool and some foundry experience. Good organiser. Work in Midlands employing 600. Salary £720 per annum, progressive.—Address, P3667, The Engineer Office. P3667 A

HEAD FOREMEN (TWO) REQUIRED to Take Charge of Day and Night Shifts in Repetition Machine Shop, producing Aircraft Parts, Berks. Approx. 100 employees. Must be experienced in Operation and Maintenance of Capstans, Autos, Mills, Lathes, &c. Give full details and qualifications, experience, and salary required.—Address, 7896, The Engineer Office. 7896 A

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MANAGER REQUIRED by Well-known Firm to Take Charge of New Department developing and selling Industrial Drying Equipment. Applicant must possess personality and drive, and only first-class men need apply. Experience of similar equipment not essential. This post offers excellent present and post-war prospects to the right man. State age, experience, and indication of salary required.—Address, 7955, The Engineer Office. 7955 A

The Engineer

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THE FACT that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

SITUATIONS OPEN

LADY TRACER REQUIRED for Training and Drawing-office Records, Enfield district. State age, experience, and salary required.—Address, 7954, The Engineer Office. 7954 A

MACHINE SHOP SUPERINTENDENT, Fully experienced and used to the Controlling of Labour, REQUIRED for large Engineering Works in the Midlands. Also MACHINE SHOP SUPERVISOR for Night Shift.—Write, stating age, full details of experience and salary required, to 7918, The Engineer Office. 7918 A

MANAGER REQUIRED for Drop Forge of Large Engineering Works in the Midlands Area.—Write, stating age, full experience, and salary required, to 7919, The Engineer Office. 7919 A

SITUATIONS OPEN

MACHINE SHOP SUPERINTENDENT REQUIRED for Light Engineering Factory in Yorkshire. Plant comprises autos, capstans, drills, mills, &c. Work of highest national importance.—Address full particulars age, experience and salary required, 7938, The Engineer Office. 7938 A

SALES and SERVICE ENGINEER REQUIRED for Nottingham, also Newcastle area, with connection among collieries, steel works, coke ovens, gasworks and (steamship companies in the Newcastle area) to sell high-quality de-scaling solution and boiler feed water treatment.—Address in full, giving age, last position held, monthly sales and salary required, P3664, The Engineer Office. P3664 A

SITUATIONS OPEN

TECHNICAL OFFICERS and ASSISTANTS (Men and Women) are REQUIRED by the Ministry of Aircraft Production in the North and South of England on the preparation of technical hand books dealing with aircraft and aeronautical equipment. Candidates are required to have experience in editing or writing technical matter; sound technical training in engineering desirable. Salaries range from £265 to £455 per annum (plus Civil Service War Bonus), according to candidates' qualifications and experience.—Apply in writing, stating if registered for employment at any office in the Ministry of Labour and National Service, to the SUPPLEMENTARY REGISTER, 4, Gt. Marlborough Street, London, W.1, quoting Order No. M1291/W689. 7933 A

WORKS MANAGER, with Thorough Knowledge of Mill and Press Shop Work, engineer training an advantage, REQUIRED for Rubber Factory engaged on essential work.—Replies to PERADIN LIMITED, Bath Rubber Mills, Bath. 7937 A

WORKS MANAGER (ASSISTANT) REQUIRED by Black Country Works with world reputation engaged essentially on Light and Medium Heavy Engineering Work of Highest Priority, but with nucleus output of established production and developments for post-war. This is thought to be an exceptional opening, and only those with full technical training, apprenticeship, practical experience of Modern Machine Shop Methods and Progressing, and capable later of greater responsibility will be considered. Strict age limits, 30 to 40.—Address, 7941, The Engineer Office. 7941 A

SITUATIONS WANTED

A PLANNING ENGINEER, Educated and well connected, skilled in 14 years' practice of plant lay-out, embodying several branches of general engineering, is OPEN to ENGAGEMENT.—Address, P3673, The Engineer Office. P3673 B

ENGINEER MANAGER, Age 37, DESIRES POSITION of greater responsibility in war effort. Specialised knowledge of training and use of semi-skilled male and female labour. Fully conversant with modern manufacturing methods.—Address, P3663, The Engineer Office. P3663 B

ENGINEER (36), Capable Supervising Construction and maintenance heavy machinery, 7 years high-pressure chemical plant, SEEKS POST. Disengaged.—Address, P3668, The Engineer Office. P3668 B

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ENGINEERING TRAINING in London Works WANTED by YOUTH, age 17½.—P. LAMBERT, 9, Earlshall Road, London, S.E.9. P3656 B

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CLASSIFIED ADVERTISEMENTS CLOSE FOR
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"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next date, December 26th.

ADVERTISEMENTS.

The Charges for Classified Advertisements are 1/- per line up to one inch—minimum charge, 4/-: those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address,
28, Essex Street, Strand, London, W.C.2.
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SITUATIONS WANTED

EXPERIENCED ENGINEER, A.M.I.C.E., M.I.M.E., DESIRES APPOINTMENT duration of war. Recent experience, railway engineering, earthworks, large factories.—Address, P3662, The Engineer Office. P3662 B

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WAR PRODUCTION AND POST-WAR PLANNING.—ENGINEER, with considerable managerial exper., 13 years gen. man. of medium works, good organiser and successful with women labour, has invented an improved machine having immense advantages over existing types used in all power laundries, master patent obtained covering both process and machine, excellent results obtained with demonstration machine. Advertiser would WELCOME an OPENING where his services would be advantageously employed and an arrangement for exploiting this invention, which promises handsome profits.—Address, P3672, The Engineer Office. P3672 B

FOREMAN ERECTOR, 30 Years' Exp., DESIRES POSITION; wide and varied experience steel buildings, tanks, conveyors, &c.; exl. references.—Address, P3674, The Engineer Office. P3674 B

AGENCIES

ESTABLISHED FIRM with Unique Connection all branches of industry, having representatives in all main industrial centres, with hundreds of live accounts, DESIRE SELLING RIGHTS for INDUSTRIAL PROTECTIVE CLOTHING and EQUIPMENT.—Address, 7943, The Engineer Office. 7943 D

LONDON ENGINEERS with Manager, A.M.I. Mech. E., and imposing offices, SEEK CONNECTIONS with provincial firms. Either agents or liaison, with clients or sub-contractors. Especially power plant and allied lines.—Address, P3675, The Engineer Office. P3675 D

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PATENTS

FORM P, AMENDT. 2.

NOTICE IS HEREBY GIVEN that the SUPERHEATER CO., Ltd., and ERIC ARTHUR ROBINSON SEEK LEAVE to AMEND the SPECIFICATION of the APPLICATION for LETTERS PATENT No. 533,858, entitled "Improvements in or relating to Heat Exchange or other Apparatus comprising Parallel Paths for the Flow of Fluid."

Particulars of the proposed amendment were set forth in the Official Journal (Patents), No. 2756, dated November 19th, 1941.

Any person may give NOTICE OF OPPOSITION to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton Buildings, London, W.C.2, on or before the 19th December, 1941. 7952 H

THE PROPRIETORS of BRITISH PATENTS Nos. 292,494, 351,079, 353,525, 354,707, 383,531, 383,532, 406,510, 414,211 and 474,275 are PREPARED to LICENSE British Manufacturers to WORK thereunder. They relate to methods and apparatus for the rolling and coiling of metal strips, bands and sheets.—Address, BOULT, WADE & TENNANT, 112, Hatton Garden, London, E.C.1. 7936 H

PATENTS

THE PROPRIETOR of BRITISH PATENT No. 511,946, for "Improvements in Apparatus for Feeding Ovens, Furnaces, or the like," DESIRES to ENTER into NEGOTIATIONS with a firm or firms for the SALE of the PATENT or for the GRANT of LICENCES thereunder.—Further particulars may be obtained from MARKS and CLERK, 57 and 58, Lincoln's Inn Fields, London, W.C.2. P3665 H

THE TRADE MARKS "KALOROIL," No. 540,604, registered for Oil Fuel-burning Plant, and "INAUDOMAT," No. 541,243, registered for Suction Pumps, Pressure Pumps, Motors, and Fans (Parts of Machines), all being Parts of Oil Fuel-burning Plant, were ASSIGNED on the 11th August, 1941, by Kaloroil Burners Limited, of Kingsbury Works, Kingsbury Road, London, N.W.9, to Templewood Engineering Company Limited, of Eastbourne Road, Trading Estate, Slough, Bucks, WITHOUT THE GOODWILL of the business in which they were then in use. Dated the 18th day of November, 1941.—JOHNSON WEATHERALL STURT and HARDY, 7, King's Bench Walk, Temple, E.C.4. 7950 H

MISCELLANEOUS

DON'T DISCLOSE YOUR PLANS.—Produce blue prints and black line copies, &c., in your own office without glass frame, privately and economically. "Arcoflex" Copiers from 28 shillings. As supplied to H.M. Government.—E. BOUGHTON, 53, Kenley Road, Merton, S.W.19. 7928 I

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MACCLESFIELD.
'Phone 2258
P3627 I

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WANTED, WATER-TUBE BOILERS, Babcock or Stirling only, up to 50,000 lb. evaporation, 200 lb. working pressure or higher.—Address, 7384, The Engineer Office. 7384 F

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ALFRED HERBERT, Ltd., Coventry, PAY BEST PRICES for SECOND-HAND MACHINE TOOLS in good condition by first-class makers.
Write, wire or 'phone, and our representative will call.
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100/150 H.P. CRUDE OIL ENGINE is WANTED IMMEDIATELY. Not older than 1933. State full particulars.—Address, 7932, The Engineer Office. 7932 F

SUB-CONTRACTING

WANTED

WORK WANTED for 2 Rhodes Power [illegible] 20-ton cap., 2in. stroke, and for [illegible] Welder, 100-amp. cap., 3ft. 6in. arm, [illegible] thicknesses.—C. S., Staffa Works, Leyton, [illegible] 7934

FOR SALE

AMERICAN 30in. Centre HEAVY DUTY [illegible] and S.C. LATHE, straight bed 47ft. admit 37ft. between centres, two saddles, [illegible] turning attachment, four-step cone, with [illegible] drive arrangement.
TWO "SHANKS" 21in. centre HEAVY DUTY S.S. and S.C. LATHES, admit [illegible] between centres, two saddles, all-geared [illegible] arranged motor drive.
DEAN, SMITH and GRACE 16in. [illegible] HEAVY DUTY S.S. and S.C. LATHE, [illegible] 26ft. 6in. between centres, two saddles, [illegible] geared head, arranged for motor drive.
TWO 16in. "TANGYE" HEAVY [illegible] S.S. and S.C. LATHES, admit 17ft. [illegible] centres, one saddle, cone pulley drive.
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COCHRAN VERTICAL MULTI-TUBULAR BOILER, 5ft. 9in. internal dia., [illegible] high, insured 175 lb. pressure, grate area [illegible] ft., heating surface 350 sq. ft. Seen in operation at Glasgow.—Address, 7944, The Engineer Office. 7944

12-TON Butler STEAM TRAVELLING CRANE, 35ft. jib, to lift 12 tons on 7ft. gauge, 16ft. radius, or 8 tons at 16ft. radius, 4ft. 8½in. gauge; boiler 100 lb. w.p.—GEORGE COHEN, SONS & CO., Ltd., Stanningley, [illegible] 7940

For continuation of Small Advertisements see page 64

6-10

The Height of Achievement

ON a mountain top in Australia is the chalet shown in the photograph—supplied with electricity generated by a Petter Engine.

Equally high is the position occupied by Petter engines in the estimation of engineers the world over. Our post-war range, for which plans are now well forward, will fully maintain this reputation.

PETTERS LTD., LOUGHBOROUGH, ENG.

A Seven-Day Journal

Regional Fuel and Power Controllers

THE President of the Board of Trade, Sir Andrew Duncan, has appointed Regional Fuel and Power Controllers in the Civil Defence Regions to co-ordinate the regional activities of the Departments concerned in respect of coal, gas, electricity and oil and, in emergency conditions, to take charge of these interests under the Regional Commissioner. The day-to-day administration of these Departments in the Regions will continue as at the present, and these appointments will not affect the work or position of the Board of Trade Representatives on the Production Executive's Regional Boards. The appointments are as follows:—Scottish Region, Sir Nigel Campbell; Northern Region, Mr. Clive Cookson; North-Western Region, the Earl of Crawford; North-Eastern Region, Dr. H. S. Houldsworth; North Midland Region, Sir William Firth; Midland Region, Sir Bernard Docker; Eastern Region, Mr. H. H. Holmes; Welsh Region, Mr. E. L. Hann; Southern Region, Colonel H. W. Woodall; London and South-Eastern Region, Colonel J. C. Dalton. The appointment to the South-Western Region is to be announced later.

Sources of Fuel for Producer Gas

THE Secretary for Mines, Mr. D. R. Grenfell, has invited the Committee which, under the chairmanship of Lord Henley, considered low-temperature carbonisation processes last year to reassemble. He has asked it to examine the sources of fuel for producer gas vehicles, to estimate the quantities that could be made available at present, and to report on the measures that would be required to increase the supplies if necessary. The Committee will also inquire whether the development of the country's peat resources would make any useful contribution to the supplies of domestic fuel in the present coal situation. The constitution of the Committee is as follows:—Lord Henley (Chairman); Mr. Gordon Macdonald; Mr. W. H. Mills, Professor of Stereochemistry in the University of Cambridge; Mr. F. B. Richards, chairman of Woodall-Duckham Company; Mr. J. Shearman, road motor engineer, L.M.S. Railway; Mr. T. E. B. Young, general manager, Bolsover Colliery Company; Mr. W. A. Macfarlane (Secretary); and Dr. F. S. Sinnatt, Director of Fuel Research (Department of Scientific and Industrial Research); and Mr. J. A. Brook, Mines Department, Assessors.

The Control of Machine Tools

THE Control of Machine Tools (No. 9) Order, 1941, made by the Minister of Supply, which became operative on Tuesday, November 18th, is intended to ensure that machine tools are used to full capacity in furtherance of the war effort. In accordance with the provisions of the Order, every person in the United Kingdom who has had in his possession or control certain specified types of machine tools that have not been worked for more than 60 hours in the aggregate for any period of 60 consecutive days is required to furnish particulars of such machines to the Machine Tool Control, 35, Old Queen Street, London, S.W.1. The particulars must be furnished within seven days of the period laid down, and the person having possession or control must not move a machine except under licence or a special direction given by the Minister of Supply.

Loss of the Aircraft Carrier H.M.S. "Ark Royal"

ON Friday last, November 14th, the aircraft carrier H.M.S. "Ark Royal" sank early in the morning while in tow to Gibraltar. The ship was, according to the Admiralty communique, torpedoed by a U-boat in the Mediterranean east of Gibraltar late on Thursday. After the torpedo had exploded the ship almost immediately listed over to about 15 deg. Every effort was made by her officers and crew to get her to harbour, but that was not possible. All but one of her ship's complement of close upon 1600 officers and men are safe. The "Ark Royal" will go down to history as one of the most famous ships of the war. She saw service off Norway, in the Arctic Ocean and the Southern Seas and in the Mediterranean, and at one period she was at sea continuously for thirty days, during which she steamed close upon 15,000 miles. She was built by Cammell Laird and Co., Ltd., being launched on Tuesday, April 13th, 1937, and completed in the November of the following year. Some excellent pictures of her launching will be found in our issue of April 23rd, 1937. A full technical account of the design of the ship was given in a paper read by Sir Stanley V. Goodall, Director of Naval Construction, before the Institution of Naval Architects on March 29th, 1939. That paper was reprinted in THE ENGINEER of March 31st, 1939.

The Newcomen Society

THE first ordinary general meeting of the Newcomen Society was held on November 5th, 1921, and the Society's Coming-of-Age was therefore celebrated at the twentieth annual general meeting which took place at the Institution of Mechanical Engineers on Wednesday, November 12th. During the early part of this meeting, Mr. E. Wyndham Hulme, one of the founder members, presided. The annual report, which was presented by Dr. H. W. Dickinson, showed that 349 new members had been elected during the year, bringing the total membership up to 1779. It is interesting to recall that at the first meeting of the Society the election of 25 members was announced. Mr. E. Lancaster Burne was elected President in succession to Dr. C. E. Davies, of New York. A note by Mr. A. Titley, the Society's first President, on "The Beginnings of the Society"—printed in our last issue—was read in the author's absence by Dr. Dickinson, after which a paper on "Suffolk Windmills" was presented by Mr. R. Wailes.

Labour and Production: The Select Committee's Twenty-fifth Report

THE twenty-first report from the Select Committee on National Expenditure dealt with the output of labour, and submitted in a summary at the end of the report thirty-two recommendations on labour and production. As these were the concern of several Departments, the Government decided to make one comprehensive reply in place of the separate departmental replies which are usually submitted in such a case. The twenty-fifth report, which has been recently issued by the Stationery Office, price 6d., sets out and comments on each of the thirty-two recommendations of the twenty-first report, and contains also other statements made by the Government on other questions affecting labour and war production which are not specifically dealt with in the report. It is interesting to see that in the majority of cases the recommendations have been accepted, while in others they have been agreed to in principle, but present difficulties in practice which are clearly set out by the Departments concerned. With regard to the hours of work, it is stated that the Industrial Health Research Board has carried out investigations which indicate that, over an extended period, weekly hours of work should not exceed sixty for men and fifty-five for women. Efforts have been made to restrict hours within these limits. On hours of work, the Government's policy is that factories and plants should be employed for as much of the twenty-four hours as possible, with a view in particular to the fullest possible use of machine tools, in the interests of balanced production. Two long shifts or three short shifts are now being worked in an increasing number of factories. Other matters which are dealt with concern discipline, industrial relations, transport questions, food, and lighting, and incentives to output. In the other section of the report there are paragraphs dealing with the supply and training of labour, the employment of technically qualified staff on design and inspection work, the use of small production units, and the welcome reduction which has been made with regard to the number of forms and returns required from industry.

The Call-up of Men in Building and Civil Engineering Occupations

THE Ministry of Labour and National Service announces that following a review by the Government of the national building programme and in consultation with the Ministry of Works and Buildings, it has been decided that it will be possible during the period January to June, 1942, to release a very substantial number of men now employed in building and civil engineering occupations for service in the Defence Services and for munitions work. Ages of reservation will be raised on December 15th by an average of about five years in the case of practically all the trades affected. Applications by employers for the deferment of the calling up of men affected by these changes on the ground that they are employed upon essential work must be made at a local office of the Ministry of Labour and National Service by Monday, December 1st, 1941. Men in a number of the specified occupations whose ages at registration were below their respective ages of reservation have hitherto been called up to the Defence Services only as Service tradesmen. It has been decided that such men shall in future be available for calling up also for general service.

Motor Vehicle Repairs and Spare Parts

IN a Journal note of September 26th we outlined the provisions about to be made by the Ministry of Supply and the Ministry of War Transport for the regulation of spare parts for vehicles which may be required for the repair of vehicles immobilised or likely to be immobilised for the want of spare parts. It is now announced that all motor vehicle and component manufacturers now require that certain spare parts notified by them to their distributing agents, as being in short supply, shall only be issued if a certificate of need is completed. If the manufacturer cannot meet orders for which certificates of need have been completed and cannot, moreover, promise delivery within twenty-one days, the certificate of need is returned, with a notification of the estimated delivery date, which is passed on to the operator. This procedure now applies to all civilian-operated vehicles, and also to Government vehicles where parts are ordered through civilian repairers. On returning the certificate of need the manufacturer will indicate that the operator, if he so desires and if his vehicle is engaged on important national work, may then apply for Government assistance to the appropriate Regional Maintenance Officer (Certifying Officer) of the Ministry of War Transport. That officer, on presentation by the operator of a returned certificate of need, may, where warranted, pass a spares shortage certificate to the Ministry of Supply. This certificate is a request for special assistance in obtaining spare parts which have not been obtainable through the ordinary trade channels. Reconditioned engines will not be changed for old engines, except on Government application being made to the Regional Maintenance Officer. Certificates of need are not required by manufacturers for wheels or tyres, but in case of difficulty the Regional Maintenance Officer will be prepared to assist. In Northern Ireland civilian operators of motor vehicles must apply to the Ministry of Home Affairs. Supplies of certificates of need are available on demand at the various Regional Transport Commissioner's offices of the Ministry of War Transport.

Further Canadian Locomotive Experiences

By EDWARD H. LIVESAY

No. VIII

(*Continued from page 52 July 25th*)

FAST TRAINS—"THE CHINOOK," C.P.R.

THERE are not many really fast trains in Canada. By "fast" I mean through trains averaging over 50 m.p.h. between terminal points. Inquiries—which may be incomplete, but are probably correct—have only brought to light half a dozen that can be fairly so called, and I recently made a point of riding in the cabs of the engines hauling some of them to find out just what the fastest Canadian locomotive work was like. I have now got a pretty good line on it, as they say out here. I rode with four of the speediest trains I could pick out. One in the West, "The Chinook," between Calgary and Edmonton, and three in the East, taking numerous notes *en route*, including times, distances, speeds, and what not. This meant considerable self-sacrifice on my part, which I feel justified in drawing attention to. Describing my British locomotive experiences, I admitted that nothing bores me more on the footplate than messing about with a watch when there are so many other things to look at of far greater interest and importance. Translation across the Atlantic has not affected this repulsion. Timing and measuring still bore me. They apparently bore my watch, too, as it "chucked its hand in" during one hectic trip in the East, and still refuses to be good. I cannot blame it. I had no right to ask it to do what I objected to doing myself. But a certain amount of timing is necessary if it is intended to deal subsequently with the performances of fast trains, so on these runs I stoically recorded the fleeting hours and minutes—seconds were beneath my dignity. The result will come into this and forthcoming articles.

Though the overall average speeds of fast trains in Canada are not as high as in England, intermediate speeds—between stops—are often not much lower, and in any case are very good. It should be remembered that not only are loads as a rule heavier, and stops more frequent, but railways out here, though fenced, are cursed with innumerable level crossings, on which a train is always liable to collide with car or truck, in the care (save the mark !) of some congenital idiot who has tried to "beat the train to the crossing," and has misjudged his distance. The funerals of these people do not take place often enough. Yet engineers have to try and save them from themselves, so very high speeds are frowned on by officials, and moderation preached. Further, bearing in mind the far heavier engines and equipment in Canada, imposing great stresses on track and mechanism, high speed costs too much. Lastly, there are fewer trains running between large centres of population than would be the case in England, so they have to serve many intervening towns and villages as well, which naturally cuts down average speeds considerably.

There are only two trains I know of in Canada roughly the equivalent of the well-known long-distance trains in England, such as "The Flying Scotsman" and "Royal Scot," to mention only those typical examples. They are "No. 15," running from Montreal to Toronto, and "No. 6," in the reverse direction. The former will be dealt with at a future date. A comparison between these outstanding trains is interesting, and is made in simple form below :—

Representative Canadian and British Express Trains

Train.	Route.	Miles.	Speed.		Load, tons.	Stops.
			Time, hours.	M.p.h.		
No. 15, "The International"... No. 15, "The Canadian"	Montreal–Toronto	333·8	6½	51·4	750–1000	11 (9 booked, 2 coal and water)
No. 6, "The Inter City" ... No. 6, "The Royal York"	Toronto–Montreal	333·8	6½	51·4	750–1000	10 (8 booked, 2 coal and water)
"The Flying Scotsman" ...	London–Edinburgh and *vice versâ*	392·0	7	56·0	500	None
"The Royal Scot"...	London–Glasgow and *vice versâ*	402·0	7	57·4	500	One

Nos. 15 and 6 are "Pool" trains, run jointly by the C.P. and C.N. railways, but with C.N. power, and appear under different names in the respective time-tables, as shown.

There can be no doubt as to which trains involve the heaviest work. The eleven stops made by the "International" occupy about 40 min., leaving only 350 min. for the 333·8 miles, and making the running average speed 57·2 m.p.h., with no allowances for slowing to, and picking up after, stops. This, too, with a load of 750–1000 tons. The two runs I have made in the cab with this train impressed me very much. The engine was caned most of the way, the speed seldom falling below 65 m.p.h., and often reaching 80. Things were very different on "The Flying Scotsman." The engine—No. 4491, "Commonwealth of Australia"—simply played with its job on both runs, and the fireman never showed even a sign of perspiration ! The maximum speed recorded was 90 m.p.h. Certainly mechanical stoking was not needed on those occasions. It was much the same with "The Royal Scot," except on Shap and Beattock, where both engine—No. 6227, "Duchess of Devonshire"—and fireman had to show what they were made of. These gradients are far more severe than anything the Canadian trains had to tackle between Montreal and Toronto. But I must get back on to the main line again—I have been running on a side-track long enough. I digressed a little to bring out the essential differences between British and Canadian conditions, as they affect locomotives on fast trains. At present we are concerned with "The Chinook," a Western Canadian train, quite different from services in the East.

"The Chinook"—pronounced Shinook—runs over what used to be the Calgary and Edmonton Railway, built in 1890–91, and subsequently leased to the C.P.R. in 1903. At that time the great bridge over the North Saskatchewan River at Edmonton had not been built, and the railway ended on the south bank of the river, at what is now known as South Edmonton. The bridge was built in 1910, and the railway carried across to Edmonton proper, which lies on the north bank. If the railway was built as most were in the West then, it was probably laid down as cheaply as possible, with plenty of curvature and gradients, in spite of its prairie location. Cuttings and embankments were avoided except where absolutely necessary, and though no doubt considerable improvement was carried out by the C.P.R. when the line was leased to that company, it is still somewhat sinuous, with a see-saw profile, and not specially suitable for high speed travel. Scenically, it is nothing particular; the Rockies are in view at the Calgary end, far off to the west, but they recede as you go north, and are lost sight of at about the halfway point.

In a recent article—THE ENGINEER, July 25th, 1941—I referred to the possibility of a limited revival of the four-coupled engine in North America, for service with light, fast trains, a reincarnation having taken place a few years ago, but expressed doubt as to whether the type really had much future, at any rate in Canada. The article described some of the work being done by an engine of this wheel formation in Eastern Canada, one of the C.P.R. 4–4–4 "2900" class; or, rather, work that was then being done, because when visiting the East recently I found that these engines had been taken off the services dealt with in that article, and six-coupled engines reigned in their stead. A faint feeling of self-congratulation came over me when I noticed this; not that I was pleased to see it, but the article was intended to point a moral—that four-coupled engines were not really suitable for service on fairly fast trains hampered by frequent stops—trains which varied a good deal in weight and had to work over considerable gradients, a description which fits in pretty closely with

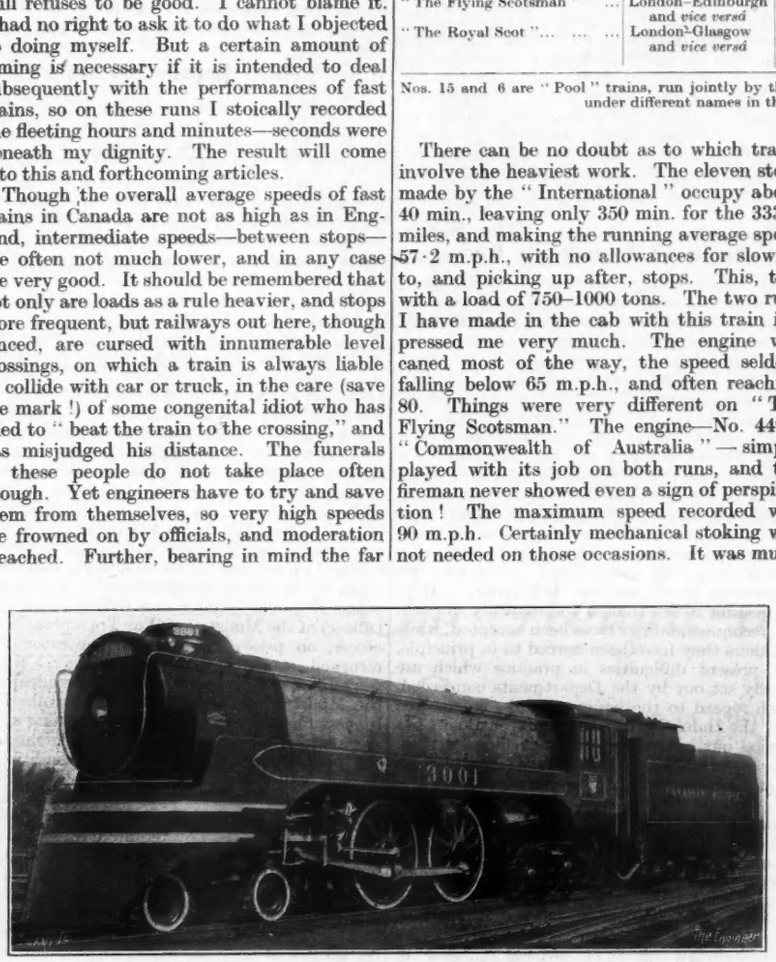


FIG. 29—C.P.R. "3000" CLASS LOCOMOTIVE

those operating over the Montreal, Peterboro, and Toronto route. I pondered a little over the concluding paragraphs before venturing them, not wanting to hurt the feelings of such an attractive engine as "No. 2925." However, the paragraphs were meant to sum up my conclusions; yet to do it considerately, without excessive dogmatism, and certainly without decrying the engine, which could obviously do well on suitable duties, and which I liked very much. The trouble was it was not engaged on suitable duties; it was a misfit, and hence its subsequent withdrawal.

In the same article I touched on the genesis of the 4–4–4 in Canada, beginning with the C.P.R. "3000" class, but could say little about it, as up to that time I had had no actual experience of it. Circumstances have now changed. I have recently had a trip on "No. 3001," with "The Chinook," one of the fastest trains in Western Canada—probably *the* fastest—one of the trains that the "3000" class was, I believe, built to handle. But just as with "No. 2925" in the East, so with "No. 3001" in the West. The engine seemed somewhat of a square peg in a round hole. Instead of being at the head of a light, four-coach train weighing, say, 175 tons, one in keeping with its *raison d'être*, I found it doing its strenuous best with seven cars weighing about 350 tons, running on the same fast schedule that had been laid down for the lighter train. This saddened me; it was as though a racehorse had been put between the shafts of a wagon. There really ought to be a Society for Preventing Cruelty to Locomotives—I must write to *The Times* about it.

Notwithstanding this lack of consideration for "No. 3001," or perhaps because of it, my experience with "The Chinook" was very interesting. The "3000" class is unique in Canada, and as it only comprises five engines, and there are never likely to be any more, it merits description, the design showing a number of unusual features. Moreover, it is probably the Swan Song of the four-coupled engine in Canada—together with its offspring, the "2900" class—so its performance in the heyday of youth deserves to go on record.

These engines were built in 1936, together with sixteen light all-steel cars, to make up four trains, with one engine in reserve. They were designed by Mr. H. B. Bowen especially for fast work, and on the assumption that all the speed necessary could be attained by steam as opposed to oil engine propulsion, at lower cost and with longer life. The light cars give a high degree of comfort, and certainly so far as my experience goes they are an improvement on the older type of car, being easier riding, in spite of their lesser weight. They run on eight wheels and are semi-streamlined, with lower, rounded roofs in place of the clerestory pattern formerly standard, and, of course, are air-conditioned. The engines, called the "Jubilee" class, because they came into being fifty years after the C.P.R. began operation in 1886—are the first 4–4–4s in Canada. The main frames are cast in one with the cylinders, and are of nickel steel.

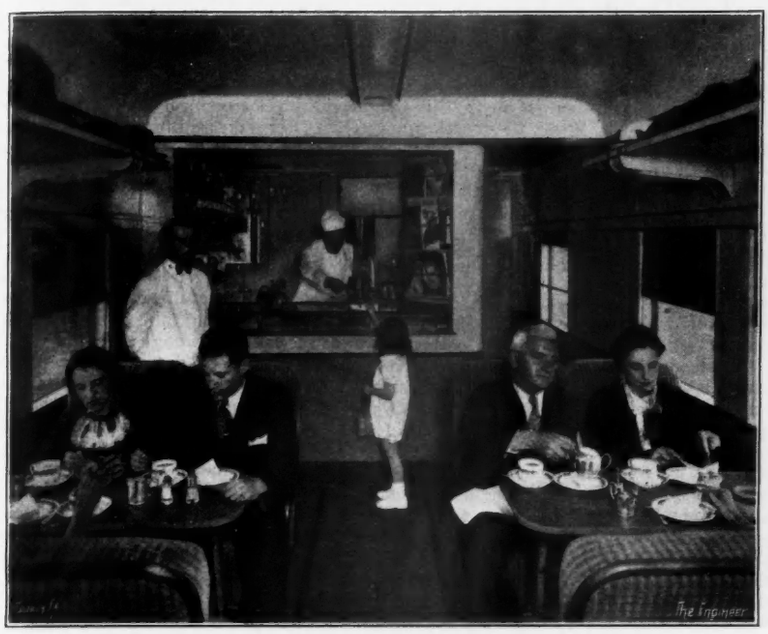


FIG. 30—BUFFET CAR OF STREAMLINED TRAIN

The driving wheels are of the "Boxpok" type, and the "Woodard" tandem rod arrangement was adopted (Fig. 31), the big ends being forked, spanning the coupling-rods, working on a floating bush common to both and bringing the two rods into line, halving the stress on the pin, and reducing its bending moment. (In passing, why not revert to that old and simpler plan, feasible where, as in this case, the connecting-rods drive the first coupled axle, merely fitting the connecting-rods inside the coupling-rods, next the wheel?) Sand is put down before both pairs of wheels, and clasp brakes are used throughout, except on the leading wheels of the trailing truck. The braking power on the drivers is 80 per cent.; on the leading truck and leading wheels of the trailing truck, 45 per cent.; and 72 per cent. on the trailing wheels. The tender truck ratio is 50 per cent. when the former is fully loaded. The front coupler can be folded up and covered with a panel, and the cow-catcher is of plate form.

The coupling and connecting-rods are nickel steel, and crossheads the "Laird" single-bar type. The motion is cross-counterbalanced, a supplementary weight, which can be adjusted if necessary, being fitted at 90 deg. to the main weight. At 90 m.p.h. the revolutions are 378 per minute, and the piston speed 1000ft. per minute at 51 m.p.h. Flange lubricators act on the leading coupled wheels, and an eight-feed "Nathan" mechanical feed takes care of cylinders, valves, and guide bars. It is driven from the combination lever, while grease is used on spring and brake gear and main and side rods. Roller bearings are fitted throughout, except to the driving axles.

The boiler is of nickel steel, without a dome, a dry pipe giving a steadier water level; the safety valves are mounted on the manhole, and the bell near the left guide bar. Only the streamlined chimney projects above the boiler casing, and makes a place for the number lamps. Fittings include an Elesco feed-water heater, Hancock live steam injector, Schmidt superheater, and multiple throttle. Superheated steam is taken from a turret to blower, stoker engine, brake pump, feed heater, whistle and dynamo, which is beneath the cab floor. The injector and train heating take saturated steam. The fire-box has flexible stays, four arch tubes and a rocking rosebud grate, and the ashpan has side doors. The air and feed pumps are

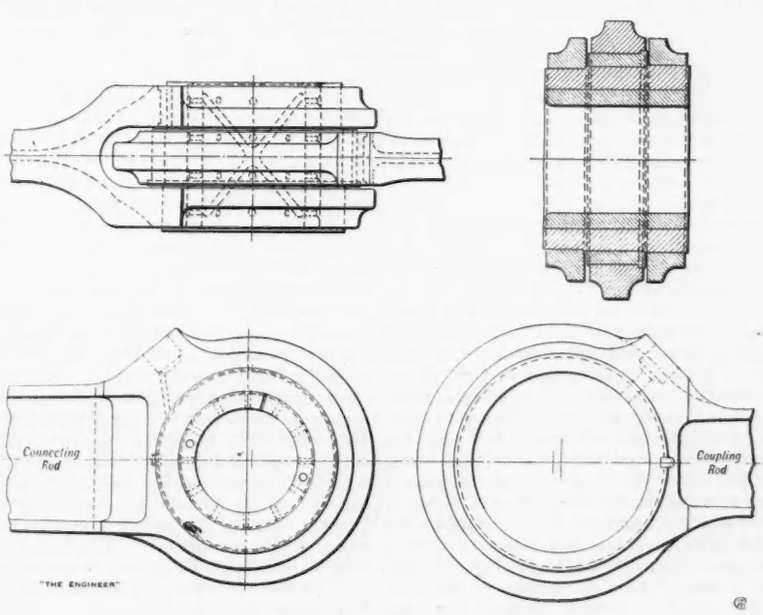


FIG. 31—"WOODARD" TANDEM ROD DESIGN

placed on opposite sides of the engine, on a frame cross-tie, giving better balance, and making access for repair easier. The rear of the tender is brought close to the train, in a dummy vestibule manner, to give continuity of outline and reduce wind resistance. "No. 3001" does about 1000 miles between washouts, and averages 77,000 miles running per year. The chief dimensions are given below :—

Cylinders		17½in. by 28in.
	centres	77in.
Valves :	Diameter	9in.
	Travel	6½in.
	Lap	1¾in.
	Lead	¼in.
	Ex clearance	¼in.
	Maximum cut-off	84 per cent.
Barco power reverse		
Wheels :	Driving, diameter	6ft. 8in.
	Leading truck	2ft. 9in.
	Trailing truck	3ft. & 3ft. 9in.
Weight :	On drivers	53 tons
	Of engine	117 ,,
	Of tender	88 ,,
	Total	205 ,,
Boiler, diameter		69 7/16in. & 75in.
Tubes		47
	Diameter	2¼in.
Flues		120
	Diameter	3½in.
	Length	19ft.
Grate area		55·6 sq. feet
Standard stoker		
Heating surface :	Tubes and flues	2601 sq. feet
	Fire-box	198 ,,
	Arch tubes	34 ,,
	Superheater	1100 ,,
	Total	3933 ,,
Pressure		300 lb.
Tractive effort		26,500 lb.
Height		14ft. 11½in.
Width		10ft. 8in.
Boiler centre line		9ft. 10in.
Coal		12 tons
Water		7000 gallons

The picture reproduced on page 346 from a previous article shows the appearance of locomotive "No. 3001."

"The Chinook" runs between Calgary and Edmonton, cities each with a population of about 100,000, 194 miles apart, the latter the capital of Alberta, on the bank of the North Saskatchewan River. It takes its name from a warm west wind, with birthplace the Pacific, a climatic prank peculiar to Alberta. Picture a snappy winter morning, 20 below, the powdery snow glittering in brilliant sunshine under a blue sky, and the air as exhilarating as iced champagne. The wooden sidewalk squeals under foot, your breath smokes and nostrils sting as you walk briskly along, with fur collar well above your ears. It is evidently going to be a real cold snap. But—what is that bank of dark cloud in the west, resting on the sharp peaks of the Rockies ? The Chinook is coming ! Down through the foothills it sweeps, and away out over the wide plains to the east. In a few hours the snow has disappeared, and you are slipping and slithering in viscous black mud, with the thermometer up in the 50s. The Chinook has come—and gone !

Calgary lies at an elevation of 3438ft., Edmonton at 2185ft., so the gradient tendency is downward for the northbound train, on which I rode, but in spite of this the profile is saw-tooth, with plenty of stiff inclination and considerable curvature. Getting away from Calgary at 5 p.m., O.T., in charge of Engineer Dean and Fireman Carswell, with Master Mechanic Allan also in the cab on special duties, the load was seven cars, made up of the four regular streamliners, plus three heavy illegitimate additions, bringing the weight to approximately 350 tons, about double what the engines were originally meant to handle on this service. The get-away was good and acceleration rapid, with the help of sand, but in a couple of miles a stop was made at the beginning of single track, coinciding with passage of the Bow River bridge. Having crossed this, the track, of long straights and sweeping curves, stretched ahead through the bald prairie, the jagged blue outline of the Rockies showing up to the left against the western sky. The permanent way seemed sufficiently good and the speed soon rose into the 60s, bringing to life that familiar rhythmic thud, a left-side box-pound. "No two-cylinder engine complete without it" in my experience !. There was a strong side wind, and the coal was fine and dusty, but a mechanical stoker adjusted accordingly soon offsets such inhibitions, and at Airdrie steam was up to the working 300 lb. The fire had been a little troublesome right from the start, and steam down to 260, calling for rocking of the grate—which is in four sections—and use of the rake. The Ashcroft exhaust pressure gauge was not working. It seems rather a temperamental fitting, informative when behaving itself, but a little apt to be under the weather or something. The Standard stoker had the usual five jets blowing coal into the fire-box, but I think the one looking after the centre of the grate was earmarked for use only with fine coal. It was fine on this occasion.

Beyond Airdrie "The Chinook" arrived first at a crossing place, and the brakeman had to attend to the switches on entering and leaving, which meant two stops ; here it began to rain a little, and slipping occurred. At Crossfield, the next stop, we were five minutes late, and with a snappy start, on an up gradient and wet rails, again there was a little slipping. It was mostly level or down to Carstairs—shades of the "Coronation Scot !"—with frequent but easy curvature ; speed was high along the straights, round about 75 m.p.h., as fast as I have ever done on the prairie, and three minutes were picked up. "No. 3001" was doing considerable quick rolling with a suspicion of nosing, but this was not surprising, as it is high-pitched, not very heavy, and the track was probably not pluperfect. Entering Olds, there was a good example of what is liable to happen when a truck driver's head consists solely of bone, from the neck up. A big petrol-laden tank truck approached slowly and determinedly from the left—the fireman's side—and therefore out of Engineer Dean's sight. The law ordains that a tank truck must stop before crossing a railway track, and then restart—its wheels must come to rest first. Did this pin-head driver carry out the enactment ? No ; he deliberately crossed non-stop less than 10 yards ahead of the train. A little miscalculation—a spot of engine trouble, and 1000 gallons, more or less, of flaming petrol would have spread around engine and train. It is easy to make laws, but what use are they in the face of resolute disregard such as this ? The lighter side of the incident takes the shape of remarks heard in the cab, to which everyone contributed ; they are well worth quoting, but it seems inadvisable to do so.

"No. 3001's" whistle was worked by a pedal, a very sensible home-made gadget that saved the engineer some trouble. Just one of those simple little things, so obvious when you see them, that makes one wonder why nobody thought of it before. It will probably become standard one of these days. I feel like suggesting another, off my own bat—interconnection of throttle and blower, which is generally put on when the former is shut. This may seem going to extremes, but it might save real injury sometimes—the fireman isn't always on his toes watching the engineer, ready to turn on the blower at a moment's notice. I remember one occasion, when in that wonderful L.N.E.R. "No. 4793's" cab (THE ENGINEER, October 13th, 1939), a sheet of flame pouring out of the fire-door when the regulator was closed, and rising to the roof. If someone wearing oily overalls had been standing in front of it they would certainly have caught fire.

The Bowden stop was very brief—we were away in thirty seconds. By this time the "bald prairie" had been left, and scattered clumps of trees—"bluffs" in Western parlance—were to be seen. The Rockies had receded, only showing as a faint blue line on the western horizon. There was far more curvature than I had expected, but it was mostly easy, and the speed remained high. The sky had cleared, the low sun was casting long shadows, and turning the landscape to gold. At Penhold a swarm of airmen boarded the train from an R.C.A. training school. I also find noted down "not a single under or over-bridge in the whole distance outside the terminal cities"—nothing but those disturbing level crossings. A ten-minute stop at Red Deer was spent in an across-the-street lunch counter, ending in a whirlwind exit as the bell began to toll, only outside half my order, and a grab at the handrail with the train well on the move. "The Chinook" waits for no man—certainly not for me. So at Ponoka I dropped back into the buffet car (Fig. 30) further to refresh the inner man and to sample the streamlined cars. They were air conditioned, if anything over-cooled, dustless, very easy riding and quiet. The absence of any florid decoration was pleasing, and the lighting was under the supports of the baggage racks, close down to the seats, and not in the centre of the roof, as will be noticed in Fig. 30.

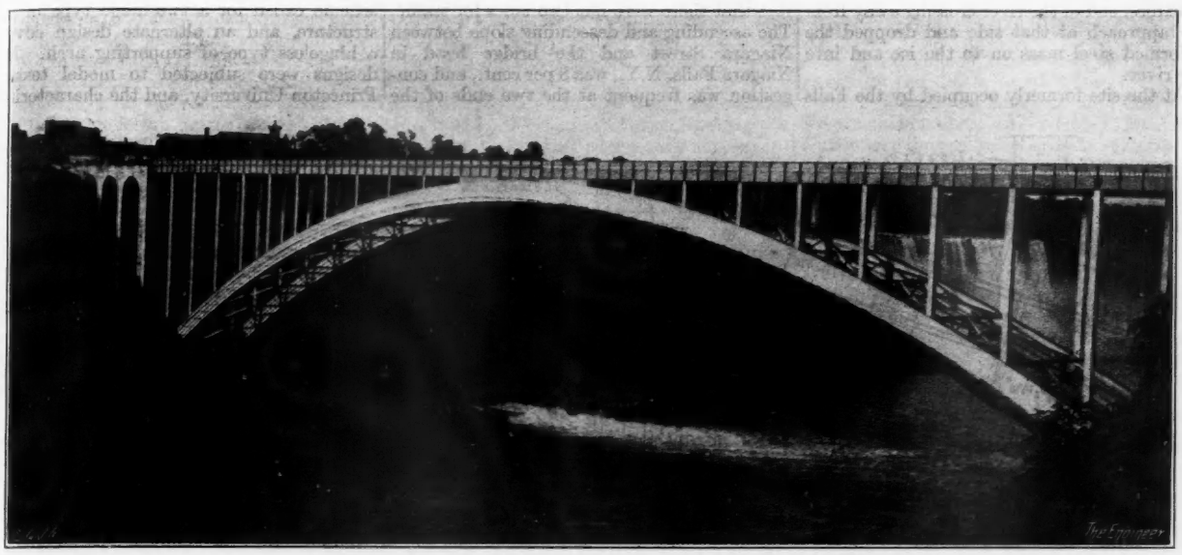
"No. 3001" had a streamlined chimney, with an air duct above the smoke-box, discharging behind the chimney. It is intended to carry the exhaust clear of the cab, but I could not judge of its effectiveness, as the engine was working hard and the steam had no chance to dribble ; the chimney was erupting like a volcano. Speed was high whenever the track permitted, 75 m.p.h. being quite the ordinary figure, and even higher here and there. The table shows that from Red Deer to the Blackfalds flag station 12 miles were covered at 59 m.p.h., start to stop, which bears this out. The whole run, in fact, was the snappiest I have ever done anywhere. Stops were always as brief as possible, get-aways were quick, and no dawdling took place between stations, only safety limiting the speed. Gradients and curves were plentiful, some of the latter calling for braking, so I think the overall average very good, though it may not look impressive. After dropping behind five minutes, the train was back on

"The Chinook," Calgary–Edmonton

Stations.	Miles.	Actual time. arr.	Actual time. dep.	Booked time, dep.	Speed.
		p.m.	p.m.	p.m.	
Calgary*			5	5	
Airdrie†	20·4	5.33	5.35	5.35	37·1
Crossfield	30·3	5.56	5.58	5.53	28·3
Carstairs	40·8	6.10	6.11	6.09	52·5
Didsbury	47·8	6.21	6.23	6.19	42·0
Olds	57·9	6.35	6.39	6.34	50·5
Bowden	68·6	6.51	6.51½	6.49	53·5
Innisfail	76·5	7.02	7.04½	7.01	45·2
Penhold	85·2	7.14	7.19	7.14	54·9
Red Deer	94·9	7.30	7.40	7.40	52·9
Blackfalds§	106·7	7.52	7.55	7.58	59·0
Lacombe	113·2	8.08	8.12	8.10	30·0
Morningside§	122·5	—	—	—	—
Ponoka	129·8	8.33	8.36	8.36	47·4
Hobbema§	141·6	—	—	—	—
Wetaskiwin	152·0	9.07	9.09	9.07	43·0
Millet	161·7	9.21	9.22	9.22	48·5
Leduc	174·0	9.37	9.38	9.38	49·2
S. Edmonton‡	191·8	10.03	10.05	10.05	42·7
Edmonton	194·1	10.15 O.T.			13·8

* Stop at Bow River bridge.
† Stops in and out of crossing.
‡ Restriction over North Saskatchewan River bridge.
§ Flag station = Halt.
Average speed, including nineteen stops, 37 m.p.h.
Average speed, excluding nineteen stops (48 min.), 43·6 m.p.h., making no allowance for slowing for, or getting away from, stops.

RAINBOW BRIDGE, NIAGARA FALLS



time at about the halfway mark, Red Deer, and from thence onward there was no more serious trouble with the schedule, the arrival at Edmonton being punctual to the minute. Under the circumstances riding was good, but naturally there was considerable rolling, chiefly on curves. One particularly vicious lurch, due to hitting a bend that I had not noticed coming at over 75, flung me sideways clean through the open door, only a blind but lucky clutch at the edge of it saving me from a crash landing. This proved that though experience is a good teacher, some people take a lot of teaching, the writer being among the number. Standing by an open cab door, making entries in a notebook when the engine is pursuing the uneven tenor of its way at high speed over a twisty track, is really not indicative of intelligence, and I admit it. I will never do it again—never.

I liked the engine very much, but I think it suffered from the same disability as did "No. 2925" in the East—there was one driving axle too few! It may be said: "After all, it did the work, so where's the complaint?" There isn't any, so far as design goes; it lies in the application of it. This was a summer run, and weather conditions were not trying, save for a little rain, which produced slipping. Had it been 20 below, or more, with perhaps a blizzard, and had a few more minutes been dropped *en route*, due to, say, station work, they probably could not have been picked up. A four-coupled engine cannot be thrashed too much or continuously; it merely brings on slipping, and you are worse off than ever. "Why not add a booster?" That is no real remedy. If you are obliged to use a booster regularly with a stopping train it proves you have the wrong type of engine. Another driving axle is evidently needed, which would be just as valuable at starting as the booster, and in addition would be available at speed up gradients, when a booster is merely so much lumber.

One of the most interesting features of this engine is the generous boiler power, associated with a pair of cylinders only 17½in. in diameter—nearly 4000 square feet of heating surface, a 55 square foot grate, and 3000 lb. pressure. It shows what the engine ought to do, and it is only the limited adhesive weight that would prevent it doing far heavier work than it was intended to tackle. The 26½ tons on each driving axle strike an English observer as heavy loading, yet the track, with rails, I believe, 100 lb. to the yard, and 39ft. long, seems to stand it satisfactorily. As I mentioned, there are no bridges outside the terminal cities and a total of only four there, unless I overlooked one. This is including the Bow and Saskatchewan River bridges.

For such work as "The Chinook" demands 6ft. 8in. wheels are needlessly large. About 6ft. would be better, giving all the speed required, and more rapid starting and acceleration. I can sum up by saying I liked the design very much—even though "No. 3001" did try to throw me off—and see no reason why it should not do fine performances on suitable duties. But it must be admitted that the average Canadian engineer does not like four-coupled engines; he prefers having plenty of adhesive weight to play with. My locomotive affections, being purely platonic, are perhaps more theoretical than practical. Anyhow, Engineer Dean and I agreed on one point—the foot-operated whistle was simply immense.

(To be continued)

Rainbow Bridge, Niagara Falls

No. I

THE Rainbow bridge, officially dedicated and opened for traffic with due ceremonies on November 1st, is the newest steel span across the Niagara River to link the neighbouring countries of Canada and the United States. This fine structure, which has cost a total of 3,760,000 dollars for both the bridge and the approach structures and plazas, again provides a much-desired crossing for modern motor traffic and a vantage point from which to view the entire sweep of the Niagara cataracts.

As will no doubt be recalled, it has been built to serve in place of the Falls View bridge, which was destroyed by an ice jam on January 27th, 1938. The circumstances leading up to the collapse of that structure influenced the designers responsible for the Rainbow bridge, which, it is believed, will be safe from the menace of future ice jams.

Ice jams in the upper gorge of the Niagara River just below the two cataracts are recurrent well-nigh annually in varying magnitude, and every now and then the ice mass and the backed-up flow of the river reach so-called exceptional heights. They are uniformly the consequence of ice, temperature and wind conditions that have developed just before at the eastern end of Lake Erie; and a recorded climax was the one that occurred toward the end of January three years ago. Then, a sharp drop in temperature produced ice 4in. thick on a wide expanse of the eastern section of Lake Erie; a succeeding and pronounced rise in temperature freed the ice from its shore contacts; and then a strong north-west wind, that prevailed for several days, crowded the floating ice to the mouth of the Niagara River and at the same time raised the level of the lake at that point about 3ft.—each foot of rise, according to competent authorities, inducing an increased flow in the river of 22,000 cubic feet a second. The field ice was swept down the Niagara and over the falls into the upper gorge between the falls and the Falls View bridge, gradually building up, not only the water level, but the ice jam to a height of 50ft. above the mean water level of the stream at that point.

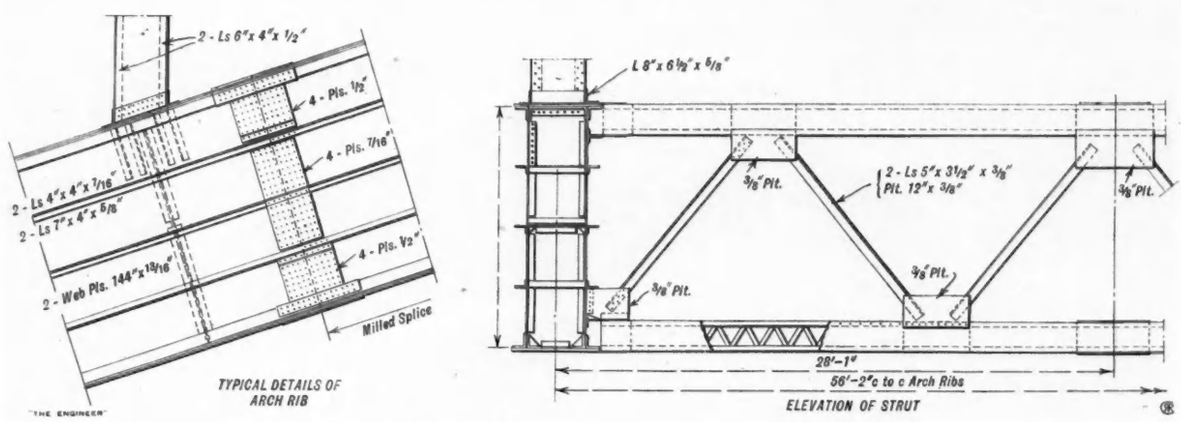
The Falls View bridge was an arch span that had a length between the supporting masonry abutments of 840ft., and the hinge pins were connected with the abutments at an elevation of about 40ft. above mean water level. The ice, when it moved down upon the bridge, was forced up into the structure between the skewbacks to a height of approximately 10ft. and gradually bent and ruptured the lower ends of the supporting arch at the

American side, finally shoving it off its footings and dropping it down into the ice, then piled upon the shore. The collapse of the American end of the structure pulled the Canadian end of the river crossing away from the approach at that side and dropped the deformed steel mass on to the ice and into the river.

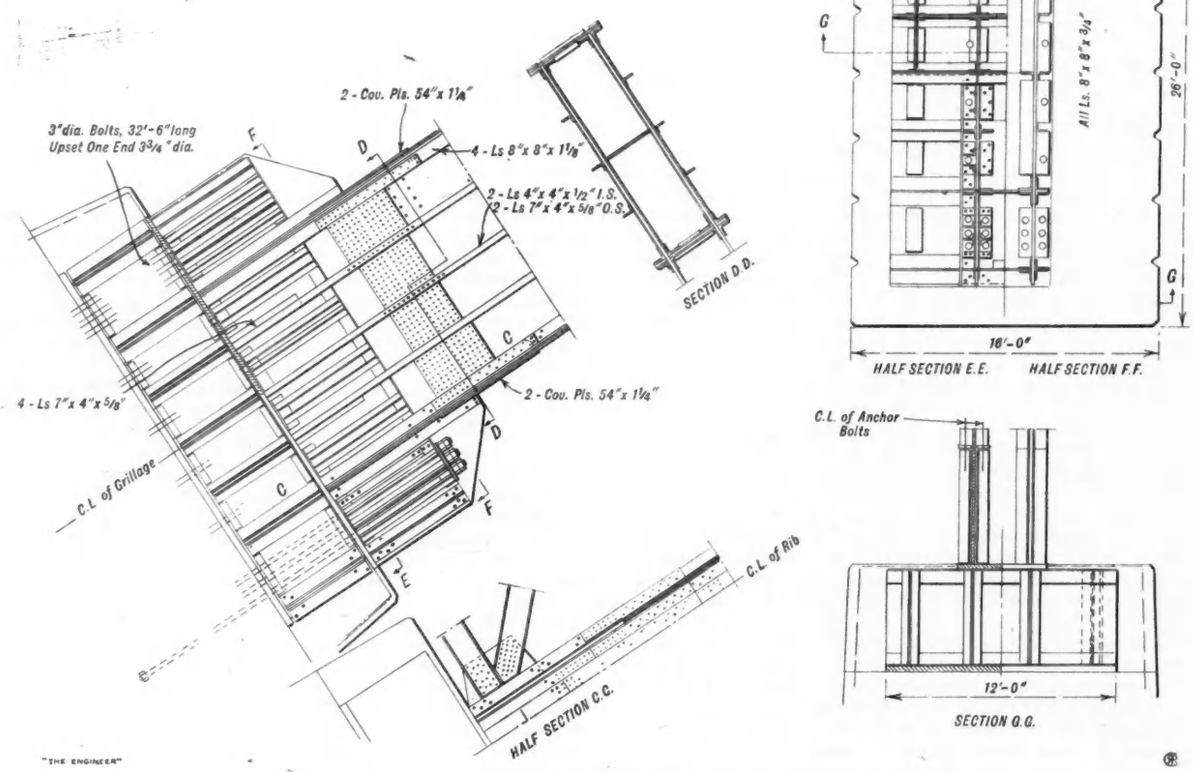
At the site formerly occupied by the Falls View bridge, which was about 400ft. farther upstream than the line adopted for the Rainbow bridge, the gorge at its top has a width of something like 1240ft., and the destroyed bridge had a total length slightly greater between the back walls of the gorge. As originally built the weight of steel in the Falls View bridge amounted to 2266 short tons. The Rainbow bridge contains 5500 tons of steel. The former span was handicapped by a growing belief among motorists that it was unsafe for modern traffic, and that attitude—right or wrong—is said to have cost in loss of traffic a good many thousands of dollars in revenue annually. The Falls View bridge was undoubtedly hampered by inadequate terminal facilities fitted for latter-day demands, but probably the most pronounced drawback was the approach gradient on the American side of the river and the fact that there were but two lanes for traffic. The ascending and descending slope between Niagara Street and the bridge head in Niagara Falls, N.Y., was 8 per cent., and congestion was frequent at the two ends of the crossing. The Rainbow bridge is of a high-level type and meets Niagara Street at the level of that thoroughfare; and on the Canadian side the crossing is above the River Road and thus avoids any interference with traffic on that highway. Furthermore, the new structure has been designed to accommodate not only automobiles, but bus and lorry traffic, and this foresight, in view of traffic surveys in the region, provides for a steadily mounting volume of future business.

In a preliminary consideration of a type of crossing to replace the Falls View bridge, both a suspension bridge and an arch span of some kind were studied. Both because of engineering and scenic reasons a suspension bridge was discarded, and attention was centred on developing a type of arch span that would best meet the different requirements of the chosen situation. The first scheme called for a two-hinge type of arch structure, and an alternate design covered a hingeless type of supporting arch. Both designs were subjected to model tests at Princeton University, and the characteristics of a hingeless arch were found to be superior to those of the two-hinge arch, although of greater weight. The Rainbow bridge has been built on the former lines.

Between the centres of opposing skewbacks the new crossing has an arch span of 950ft.—110ft. greater than the corresponding



DETAILS OF ARCH RIB AND HALF CROSS-SECTION OF ARCH

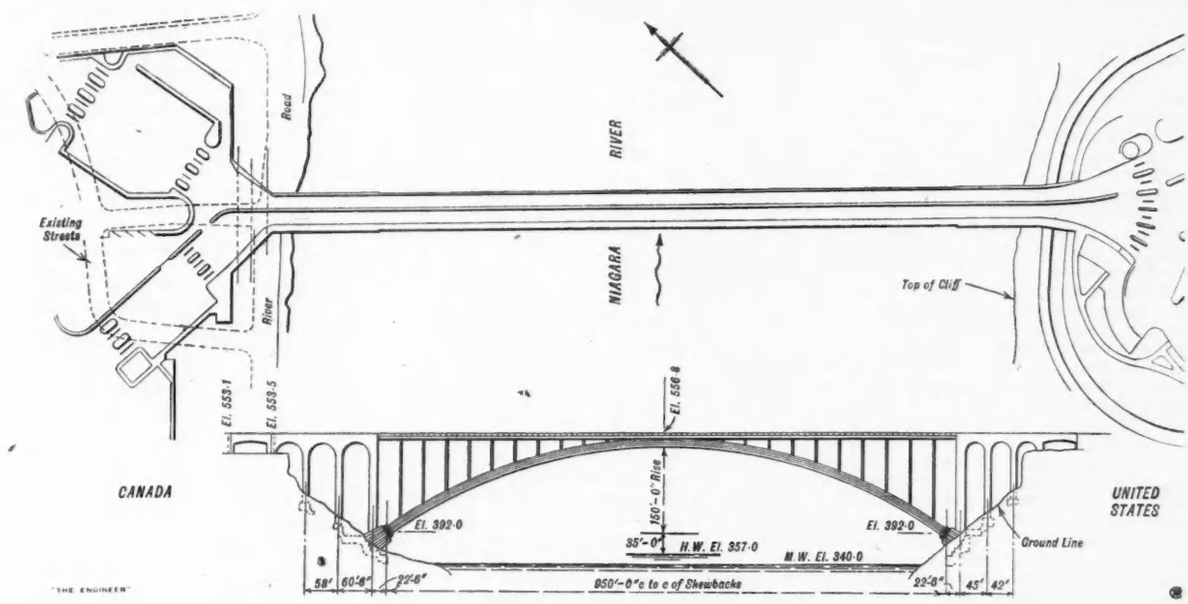


DETAILS OF GRILLAGE AND SKEWBACK AT SPRINGING OF ARCH

span of the Falls View bridge. This has made it possible to set the supporting abutments for the span 55ft. in from the shore line on each side of the stream at normal water level, and the centres of the skewbacks are also 52ft. above mean water elevation—a gain of 12ft. above the elevation of the anchorage pin bearings of the former crossing. The crown of the new arch, at the centre line of the ribs, is 202ft. above mean water elevation, and from end to end of the approach spans the bridge has a total length of about 1430ft. The deck structure has a width of 60ft. 2in. from inside to inside of the two outside kerbs, and this has made possible two 22ft. roadways, with an intervening mall 4ft. wide and a sidewalk 10ft. wide along the southern side of the structure to accommodate pedestrians and to afford an unrivalled panoramic view of the American Fall and the greater Canadian or Horseshoe Fall.

The Canadian approach is an expansive one and embraces a plaza with fourteen traffic lanes, and on the United States side there are twelve traffic lines. At each terminal where the river crossing contacts the approach spans, take care of any vertical movement due to changing loads and temperature variations. The estimated maximum of this movement is 12in. The concrete approach span at each end of the river crossing is composed of a succession of semi-circular arches that rest on concrete shafts which rise from the slopes within the gorge. The landward end of the Canadian approach is a flat segmental span that passes over the much-used River Road ; and on the American side there is a similar span that provides an overpass for a future highway that will be known as Parkway Drive.

The two ribs of the arch structure of the river crossing are carried on four concrete abutments that are set on stepped excavations in the solid rock of the gorge walls, against which the thrust of the bridge span is exerted. Each of the four 63·5-ton grillages, its surmounting 46-ton skewback, and the first rib section on each side of the river are tied to the associate abutment by thirty-two steel bolts, 3in. in diameter and 32ft. long, that are deeply anchored in the concrete.



PLAN AND ELEVATION OF BRIDGE

there are ample and up-to-date facilities for toll collectors, customs and immigrant inspectors, and for concessions to serve travellers. Each approach is being landscaped to add attractiveness in harmony with the setting adjacent to the unusual scenic grandeur of the falls.

The twin girders that form the supporting arch of the Rainbow bridge are set 56ft. 2in. apart, centre to centre, and each girder, which is of the closed-box type, has a depth of 12ft. and width of 3ft., from centre to centre of the web plates forming the two sides. Longitudinally, the web plates are strengthened by heavy angles that parallel one another at equal distances vertically on the outside of the rib, and internally each rib is further stiffened by horizontal diaphragms which coincide with the lines traced by the exterior stiffening angles. The spandrel columns, which are also of the closed-box type of construction, are secured to the tops of the ribs ; and the spandrel columns support the steel floor system and the spandrel girders. The ribs are securely interconnected by a system of lateral bracing and diagonals. The steel floor system carries a deck of reinforced concrete slabs, and expansion joints at each end of the floor system, Because of the expanse of the upturned face of the abutment, upon which the grillage is set, it was not feasible to true the entire surface of that face to the required nicety essential to the foundation for the base-plate of a prime member of the hingeless arch, which had to rise to a given point of union with the other half of the arch high above the river. Accordingly, instead of trying to true the whole surface, the expedient was adopted of truing a concrete patch, 12in. square, at each corner of the abutment face. These thin sections were ground to a uniform plane with comparative ease, and then checked by a careful survey before the heavy base-plate of the grillage was placed upon them. The intervening space between the base plate and the abutment surface was filled by grouting when the grillage had also been set in position.

(To be continued)

WAR'S DEMAND ON PLASTICS.—The U.S.A. authorities have prohibited completely the use of formaldehyde plastics in the manufacture of amateur photographic equipment, hardware, smokers' articles, advertising items, picture frames, toys and games.

Obituary

C. F. BUDENBERG

IT is with much regret that we have to announce the death, at his home, "Somerville," Marple, Cheshire, of Christian Frederick Budenberg, on November 12th. Mr. Budenberg though in his seventy-eighth year continued to take an active part in the conduct of his firm, the Budenberg Gauge Company, Ltd., Broadheath, near Manchester, until his sudden death. He was born in Manchester in 1864 and spent several of his early school years in Germany before going to the Commercial Schools, Manchester, and afterwards to Owen's College, now Manchester University, where he took his engineering honours degree. He served some time as an apprentice with Gresham and Craven, Ltd., engineers, Salford, and was then articled to Lloyd Wise, the well-known patent agent, London. Later, in 1890, he was appointed manager of Schaffer and Budenberg, Ltd. He subsequently became managing director and on the formation of the successor firm, the Budenberg Gauge Company, Ltd., in 1918, he was appointed chairman and managing director, which posts he continued to hold until his death.

While at Owen's College he studied under Professor Osborne Reynolds, who made a deep impression on him and inculcated a spirit of research which animated him in all his later work in the close investigation of basic problems in science as they affected his branch of engineering. Although it may be said that he did nothing spectacular nor sought publicity, his influence on the design and methods of manufacture of the numerous instruments made by the firms with which he was connected for over fifty years was very real. He loved his work and was never more happy than when showing interested visitors the many special features and delicate mechanical equipment of the factory at Broadheath. Mr. Budenberg became a graduate of the Institution of Mechanical Engineers in 1886 and was elected a full member in 1894.

Sorocold's Waterworks at Leeds, 1694*

By F. WILLIAMSON, F.R. Hist. S., and W. B. CRUMP, M.A.

SOROCOLD was in his day quite the outstanding figure in hydraulic engineering (to use a modern term) and a pioneer in the provision of a public water supply, including its distribution to the consumers' houses. The novelty of such an undertaking may not be apparent at first sight. Unless the source was at some elevation above the town—as rarely happened—it involved forcing water by means of pumps through closed pipes from the source to some height where it could be stored in a cistern, and from it distributed, again in closed pipes, underground through the streets and into the houses. The only materials available for pipes were either lead or the bored trunks of elm trees joined together.

Thoresby is the most important witness to give evidence of Sorocold's activities in the installation of waterworks up and down the country. In his topographical survey of the town of Leeds, approaching the bridge by way of the Calls and Call Lane, he arrives at the Pitfall, "where formerly were two Fulling-Mills, are now placed a Rape-Mill and the Water-Engine." Presently he resumes:

"The Engine beforementioned is for conveying the River-Water by Lead-Pipes to the several Parts of the Town, which was performed Anno 1695, by the ingenious Mr George Sorocold the great English Engineer, who has done the like at Macclesfield, Wirksworth, Yarmouth, Portsmouth, Norwich, Kings Lynn, London Bridge, Deal, Bridgnorth, Islington New Works and Bristol.[1]

The list can be accepted as correct, and, indeed, Thoresby states that the information was supplied by Sorocold himself. The corroborative evidence has been collected and set out by one of us recently, and need not be detailed here,[2] except as regards Leeds.

There is one important omission from Thoresby's list—the town of Derby, where "George Sorocold of Derby, gent.," signed an agreement with the Mayor and burgesses on March 5th, 1691/2, to provide a water supply. As he was resident in Derby, this can be regarded as his first contract. The rest followed in rapid succession. He was in Leeds in 1694, and the same year "Richard Barry of Westminster and George Sorocold of Derby, gentlemen," were associated in similar schemes in Norwich, Portsmouth, and Yarmouth. The last of his undertakings, so far as is known, was at Bridgnorth in 1706. There the wheel and pumps on the banks of the Severn remained in use until 1857, a continuous life of 150 years.

The facts demonstrate the complete success (and economy) of Sorocold's system, but they hardly explain the sudden demand in provincial cities and boroughs for a public water supply of this novel kind. Possibly Morris found some demand for his system outside London, for Camden in 1583 saw a forcer at work at Norwich, by which water was raised from the river and conveyed through pipes; but little is known, so far, of any other works either then or for a whole century.[3] Then Sorocold comes on the scene at Derby, and all is changed. Town after town calls him in to provide it with waterworks. Thoresby credits "Mr Hadley," a contemporary engineer, with the works at Chester, and he appears elsewhere associated with Sorocold; but Defoe names Sorocold again at Sheffield,[4] and further inquiry will certainly raise the number of waterworks installed by him, now standing at about a score.

In spite of assiduous search in recent years, the identity of "George Sorocold of Derby, gentleman," remains uncertain. He was probably a descendant of George Sorocold of Ashton-in-Makerfield, Lancashire, whose two sons, James and George, were admitted scholars at Gonville and Caius College, Cambridge, in 1645. About the same date he was a party to an assignment of the manors of Etwall and Hargate, Co. Derby, to Anne Moseley, sister of Sir Edward Moseley, so that he held estates in Derbyshire. There is no other fact known at present to account for the residence of George Sorocold the engineer in the town of Derby, or to prove him a member of the same family. Yet a description of him in 1687 suggests a man of some estate and standing in or near Derby.

The one personal record of him is the marriage of George Sorocold with Mary, the daughter of Henry Francis, an apothecary in the town, at All Saints, Derby, on December 7th, 1684. The first baptism of one of their children was in 1691, followed by other baptisms and burials. His wife, "Mrs Mary Sorocold," was buried at the same church in 1728.[5]

Bearing on these facts is a curious statement by Thoresby, to be found among many others of a like nature in the Appendix to his "Topography."[6] "Our ingenious Hydrographer, Mr George Sorocold has already had thirteen Children (of whom eight were living at the same Time) all single Births, and all nursed by his Wife, before he was twenty-eight Years of Age."

If Thoresby's statement is accepted, Sorocold could not be more than sixteen years of age at the time of his marriage. But it does not follow that this marriage was the one at Derby in December, 1684, as has been assumed.[7] It is much more probable that Sorocold was then a widower, thirty years old or more, and that he took up his residence in Derby about the time of his second marriage in that year. There are three reasons in support of this interpretation:—(i) The registers of All Saints do not corroborate Thoresby's statement; (ii) it is likely that Thoresby gleaned the facts he records from Sorocold during the latter's sojourn in Leeds in 1694, only ten years after his (second) marriage, to which it could not possibly apply; (iii) less than three years after the marriage "George Sorocold of Derby, gentleman," was engaged by the churchwardens of All Saints (now the Cathedral) "to repair the wheeles, ironwork, and frames of the bells." The work was important and a bell hanger carried out Sorocold's designs. One of the peal of ten bells was recast at the same time, and bears the names and date "1687—F. Thacker, G. Saracold." Here Sorocold was associated with "Francis Thacker of Southwood, Esq.," who had been instrumental in buying four new bells a few years earlier. It is impossible to believe that a youth of eighteen was entrusted with so responsible an undertaking. Wherever he came from and whatever works he had executed by that time, Sorocold was in 1687 a highly capable millwright or engineer, of about thirty-five years of age. Apart from the contemporary evidence, there is the fact that his "wheeles, ironwork and frames of the bells" remained in use until 1926, when it was found necessary to reconstruct the framework as the timber was ravaged by the usual pests.

Less than five years later Sorocold was again entrusted—this time by the Corporation of Derby—with the installation of a water supply, "with free liberty to erect a water-house, a water-wheel and other engines, laying pipes for conveying water into the streets, lanes and passages within the borough." The agreement was signed on March 5th, 1691/2. That system, which drew water from the river Derwent and conveyed it into a "cistern standing in the churchyard of St. Michael's," was the model for the first waterworks at Leeds.

Exactly two years later (March 3rd, 1693/4) the Corporation of Leeds approved a similar design for waterworks, laid before it by George Sorocold and a Henry Gilbert, of Netherseal (then in Leicestershire, but now in Derbyshire). The latter (whose name is written "Gillert" in the record of the Court) was probably a surveyor, and no doubt of the family of Gilbert of Locko, near Derby; but he does not appear to have been a party to the agreement, the terms of which are set out as follows[8]:—

> "The Court of Major, Aldermen and Assistants holden for the said Burrough the third day of March in the sixth yeare of the Raigne of our Sov'aigne Lord and Lady William and Mary, by the grace of god over England, &c., King and Queene [1693/4].
>
> Whereas att a Meeting of the Major, Aldermen and Comon Councell Henry Gillert of Nether Soale in the County of Leicester, Esq., and George Sorocold of the towne of Darby, gent., have proposed and doe designe to lay an engine to convey water from the River of Aire through the streets to the sev'all houses within the towne of Leeds aforesaid or to soe many of them as shall purchase the same of them. This Corte therefore takeing the same into consideracon doe judge that it wilbe a worke of publique benefitt and deserves great encouragement, for the encouragement therefore of the said undertaking and in consideracon of the some of Forty pounds to be paid by the said Mr. Sorocold to the Treasurer of this Corporacon for the use and benefitt thereof doe order And it is hereby ordered that the said Mr. Sorocold, his heires, executors, Admi'strators and Assignes shall forever hereafter be exempted by reason of the profitts and rents which he or they shall make of the said water workes of and from all and all manner of taxes, layes, and assessements to and for the poore Constable and highwayes, the Mill by which the said Mr. Sorocold conveyes the water and workes his engine onely excepted And that to be taxed and assessed att the onely usuall rate that it has bene taxed and assessed for seaven yeares last past."

This resolution was regarded as sufficient authority for Sorocold to start on the construction of the works. There are several references in Thoresby's "Diary" during 1694 to their progress, but the first one possibly relates to the preparation of the legal instrument. On July 12th he writes: "Afterwards sent for by Mr Mayor, Mr Recorder, and Mr Sorocold, about waterworks." There follows on October 1st: ". . . Dined with the lords [of the manor], and with them subscribed Mr Sorocold's lease for the new water-works." Unfortunately, no copy or summary of the document has come to light, and nothing is known of it except a formal entry in the accounts contained in "The Manor Book of Leeds"[9]:—

> 1694 8br Mr Sorrocoles license for laying pipes in ye streets. . . . [no payment]

Two more entries in the "Diary," still during 1694, show that the distribution pipes were then being laid in the streets. Thoresby watches then drawn near to his own house and enter it:

> August 22. Was several times with Mr Sorocold's workmen, who this day began in Kirk Gate to lay the lead pipes to convey the water to each family.
>
> Dec. 7. . . . With workmen till eleven; . . . after had a branch from the main pipe fixed into the kitchen, to directing which made me lose the beginning of an excellent sermon of Dr Manloves'.

Another, midway in date, records a visit to the pumping station at the Pitfall, and though it gives no details, it implies that the plant was at an advanced stage. This was on October 17th (as printed, but probably the 7th): "about three at the new waterworks; a most ingenious contrivance."[10]

(To be continued)

REFERENCES

[1] "Ducatus Leodiensis," 1715, page 80. The town names in modern spelling.

[2] F. Williamson, "George Sorocold of Derby, a Pioneer of Water Supply," *Journal* Derbyshire Archæol. Soc. (1936), lvii, 43–93.

[3] In a postscript to this paper the author refers to enterprise at York where "as early as 1616 the Corporation began to encourage attempts to distribute water in the city by conduits or pipes."

[4] "Here is a fine engine or mill also for raising water to supply the town, which was done by Mr. Seracoal. the same who fell into the river at the throwing-mill at Derby," Defoe, "A Tour," Everyman edition, ii, 184.

[5] F. Williamson, *loc. cit.*, and "Registers of All Saints' Church, Derby."

[6] "Duc. Leod.," page 607.

[7] F. Williamson, *loc. cit.*, page 44.

[8] "Court Books of the Leeds Corporation," Thoresby Society, xxxiv, page 157; also in "Municipal History of Leeds," by J. Wardell, page 63.

[9] "Observations Out of the Mannour Booke of Leeds," "Miscellanea, iii, Thoresby Soc., ix, 281.

[10] See "The Diary of Ralph Thoresby," 1830, under the respective dates.

* Reprinted from the Thoresby Society's "Miscellanea," 1941. Abstract.

MACHINE TOOLS FOR RUSSIA.—By the end of September machine tools to the value of ten million dollars had been, or were being, despatched from the U.S.A. to the U.S.S.R. to help Russia make munitions to continue the fight against Germany. The American machine tool output for 1941 will probably surpass 750,000,000 dollars.

Sixty Years Ago

SUBMARINE ARTILLERY

ON November 14th, 1881, a public trial of Ericsson's torpedo boat, the "Destroyer," took place at New York. The trials were reported to have been in every way successful. The "Destroyer" was an armour-clad torpedo boat, 130ft. long, 11ft. deep and 12ft. wide. She had engines of about 1000 I.H.P. and her speed was said to be 16 knots. Her novel feature lay in the fact that she carried a long tube on her keelson, the muzzle of which was 6ft. below water. From this tube there could be discharged elongated projectiles carrying as much as 350 lb. of dynamite. The projectiles were stated to be made of wood and they were propelled out of the submarine gun by steam pressure. Reports received from New York stated that during the trials a projectile carrying a charge of 12 lb. of powder had travelled 600ft. under water and had penetrated a torpedo net and a target representing the bottom of an ironclad. In a leading article in our issue of November 18th, 1881, we sought to show that Ericsson's invention had been anticipated in principle by Robert Fulton, who in 1813 carried out experiments to discover what could be done with guns fired under water. He found that a ball fired with 12 lb. of powder from a "columbiad" with its muzzle 2ft. under water passed clean through a target 3ft. thick placed 6ft. from the muzzle of the gun. Following his experiments Fulton designed a ship fitted to discharge a broadside of submarine ordnance, but nothing further seems to have been done with the idea until 1857, when Whitworth made some experiments on submarine artillery. In one experiment carried out at Portsmouth Whitworth used a 110 lb. Armstrong gun, which was fixed on a platform below high-water mark, loaded when the tide was out and fired when the tide was in. With a charge of 12 lb. of powder this gun sent its projectile clean through a 13½in. baulk at a range of 25ft. In 1862 Whitworth extended his experiments by firing underwater shots against the side of a wooden hulk protected by six ½in. boiler plates. With a conical shot the hulk's side was destroyed over a considerable area. In the same year Forbes, an American, carried out a number of similar experiments and entered into a contract with the United States Government to construct a partially armoured gunboat carrying a submarine gun. The contract, however, was not carried out. Concluding, we referred to some experiments then being made by our own Government, in which a light iron case resembling a fish torpedo in shape was propelled through the water by the discharge of gas at its tail after the manner of a rocket.

Future of South African Gold-Mining Industry

MUCH attention has been aroused by Mr. H. R. Hill's recent address before the South African Institute of Engineers, in which he discussed the future of the gold-mining industry. In brief, Mr. Hill calculates that with the inclusion of the proved goldfields now in course of development, the present level of activity of the industry will be practically maintained until 1950. In the subsequent decade it will decline slowly by about 15 per cent., and then more rapidly until it reaches some 50 per cent. of the present activity in 1970. The same theme was the outstanding feature of the Presidential Address of Mr. J. C. A. Meyer to members of the Chemical, Metallurgical, and Mining Society of South Africa in Kelvin House, Johannesburg, on August 27th. Mr. Meyer, who is one of the consulting engineers of the Anglo-Transvaal Consolidated Investment Company, said that any forecast of the future of the Witwatersrand gold-mining industry must be based on acceptance of the fundamental belief that gold would retain its purchasing power at a rate not less than that now established, and that among the nations the demand for gold would continue to be as unlimited as it had been throughout the ages. The calculation of the amount of payable tonnage still available bristled with difficulties by reason of the unknown factors involved. He estimated that there may still remain some 2300 million tons of payable milling ore down to a depth of 8500ft., generally regarded as the economic limit of mining as now practised, and a depth to which a number of workings had already been advanced. While he had little doubt that ultra-deep mining, down to say 13,000ft. depths, could in time be rendered practicable, viewed purely from the physiological and engineering aspects, much earnest consideration would have to be given to the economic and financial side before ultra-deep ore could be included in the national assets. Subject therefore to the reservation that the economic problems would be solved satisfactorily, he estimateed that there may be 1200 million tons available for milling lying between depths of 8500ft. and 13,000ft. An aspect of ultra-deep mining that would require the most earnest study was its limited capacity to bear taxation. Not only would a drastic readjustment of prevalent ideas be necessary, but it might even be necessary in the interests of the nation to devote public funds to assist in the raising of the heavy initial capital. Mr. Meyer, proceeding, said that the gold-mining industry of the Witwatersrand had reached a level of production which might be expected to be maintained for the next seventeen years. Thereafter there would be a declining tendency, unless previous steps had been taken to replace existing mines as they became exhausted by new producers on the unexplored sections of the Witwatersrand. Concurrently with normal production from existing and known potential producers, it might be that areas outside the Witwatersrand, particularly in the Free State and around Klerksdorp, would in some degree contribute their quota to prolonging the country's principal bulwark against the economic retrogression which must inevitably follow exhaustion of the gold resources unless effective measures were taken in good time to replace the national income by other means. With the finite life of their gold industry, it appears to Mr. Meyer that they had an immediate duty to themselves and to a not too remote posterity to strive to establish themselves as the industrial and commercial hub of the Continent of Africa, excluding perhaps the Mediterranean littoral.

"ELECTRICAL TIMES"

ONE does not have to be very old to remember the early days of electricity supply and its pioneers. Sir James Swinburne has said of them that they were eminent only because no one knew anything about the subject. "In the Kingdom of the Blind, the one-eyed man is King." Yet when we look back on the stars of those days—Perry and Ayrton, "S.P.T.," Crompton, Ferranti, Morday, Preece—we must admit that in a dark firmament they shone like a brilliant constellation. Amongst them, glowing in his great red beard, was that irrepressible genius, Robert Hammond, doing a hundred things at once and all with fiery energy; putting money into wild-cat inventions and schemes, and making enough of them pay to build up a handsome fortune. Losing much of it, and turning consultant, and making a success of that, too. He it was that fifty years ago founded *Lightning*, appointed an editor, and did most of the editing and most of the writing himself. He stamped it with his own personality, and it often sparkled, and crackled, and coruscated with wit that befitted its name. Still that name was its undoing, for the unwary called it "Lighting," and expected to find news about gas and paraffin and colza oil in it. So in 1901 the name was changed to *Electrical Times* and under R. W. Hughman's editorship it has flourished to this day, and looks good, despite the war curtailment of its format. On October 23rd it published its fiftieth birthday issue, in which we were delighted to find a reprint of R.W.H.'s article in the 2000th number of February 20th, 1930, and an excellent portrait of Robert Hammond. In congratulating *Electrical Times* on its fiftieth birthday, we wish it another fifty years of equally successful life, and may we be there to celebrate its centenary.

NEW AMERICAN AERO-ENGINE WORKS

ONE of the largest of the many new armament plants built recently in the United States is that of the Ford Motor Company for the production of eighteen-cylinder, radial air-cooled aeroplane engines of 2000 H.P. at the rate of forty per day. It is a steel-frame factory, 1400ft. by 360ft., having a volume of some 20 million cubic feet. The central portion is two stories high and is the factory proper, which is surrounded by a four-storey portion for offices and miscellaneous services, such as toilet and locker rooms, lunch rooms, tool rooms, and the air conditioning plant, which maintains a uniform temperature of 70 deg. Fah. A wing, 75ft. by 700ft., serves for an engine test department. A tunnel for piping and another for electrical cables extend the full length. Fluorescent lighting is used, and all incoming air is passed through electrostatic filters. In the soft wet clay welded steel pipes 100ft. long and filled with concrete form the foundations for columns spaced 30ft. between centres. For the second floor framing, designed for a live load of 250 lb. per square foot, double-web plate girders are used, the webs being riveted against both sides of the columns, while the bottom flanges carry rails for the 5-ton overhead travelling cranes. Only alternate columns extend to the roof, the framing of which consists of trusses of 60ft. span. The floors are of concrete, with wearing surface of square creosoted wood blocks. The walls are of brick, but a large proportion of the wall area is of glass in steel framing. Services include both direct and alternating current at four voltages, steam, water, compressed air, &c., but the electrical apparatus is mainly arranged in underground chambers, so as to be clear of the working areas. Elaborate conditioning of the air as to temperature, humidity and cleanliness is essential, in view of the extreme precision required in aircraft engine work and the inevitable dusty condition inside an ordinary manufacturing plant. A curious feature in the construction of this huge building was that in order to prevent winter delays, all work except the first part of the steel framing was done with the site enclosed by a shell of fibre board on a timber framing, with steam heat supplied.

REGISTRATION OF BUILDERS AND CIVIL ENGINEERING CONTRACTORS

SINCE the recent registration of over 104,000 builders and civil engineering contractors, an analysis has been in progress. The following are some of the figures produced of the 86,580 firms in the following trades:—General builders, building and civil engineering contractors, civil engineering contractors, plumbers, joiners and carpenters, painters, roofers, plasterers, glaziers, demolition contractors, scaffolders, and miscellaneous.

No. of Employees.	No. of firms.	Percentage of workpeople. Craftsmen.	Labourers.
0–19	79,985 ...	64·16 ...	35·84
20–99	5,371 ...	54·52 ...	45·48
100 and over	1,224 ...	38·02 ...	61·98

LIQUEFIED PETROLEUM GAS.—The use of this form of transportable fuel is expanding in the United States, where the sales in 1940 showed an increase of 40 per cent. over 1939. The sales of so-called "bottled" gas for domestic use increased by 53 per cent., while gas manufacturing companies purchased 31 per cent. more liquefied petroleum gases in 1940 than in 1939 for mixture with their manufactured gas and for direct distribution through their lines to consumers. Deliveries of liquefied petroleum gases for consumption as an industrial fuel, which made an outstanding gain of 59 per cent. in 1939 in contrast to a loss in 1938, increased only 12 per cent. in 1940. The rapidly increasing use of liquefied petroleum gases as a fuel for internal combustion engines is indicated by the 81 per cent. gain in sales for this purpose in 1940, compared with 1939.

The Engineer

NOVEMBER 21, 1941

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THE INTENSIVE TRAINING OF ENGINEERS

A MEMORANDUM issued last week to engineering firms by Lord Hankey's Technical Personnel Committee—a body set up at the request of Mr. Bevin, the Minister of Labour and National Service—outlines a scheme designed to meet the situation which has arisen as a result of the transference of highly trained technical men from industry to the Services. Impressed by the fact that, if industry is to be maintained at its present level of efficiency and output, these men must be replaced, the Committee proposes that others should be trained to take their places. It has accordingly asked the Board of Education and the Scottish Education Department to provide facilities at 116 technical colleges for intensive courses of six months' duration in the principal branches of engineering. Suitable men are to be selected by engineering firms from their staffs and workpeople, and while undergoing the six months' course these men, in addition to receiving free tuition, are to be given State grants ranging from £75 to £160 per annum, according to locality and other considerations. The type of man to be selected, the memorandum says, will, generally speaking, be one with at least a year's industrial experience, and holding the ordinary National Certificate in Mechanical or Electrical Engineering, the Higher School Certificate, or similar educational qualification. If the demand for training under the scheme reaches the size anticipated, the full-time staffs of the colleges, even when supplemented by retired teachers and other suitable persons, will, it is asserted, be insufficient to meet the requirements of the scheme. The Committee therefore proposes that, where necessary, industry should be asked to release qualified employees to assist in the work of teaching. The colleges listed in the memorandum have been requested to begin the courses of instruction with the least possible delay after sufficient applicants have been approved to form a class of, say, twenty students. Lest there should be any doubt on the point, it should be stated that the trainees after their college courses have been completed are to return to the works; it is not the intention of the scheme—as it might, conceivably, have been—that they should be used to replace in the Services the highly trained technical personnel who have already been transferred in order to set these men free to return to industry.

The particulars given in the memorandum are hardly sufficient to justify our expressing either approval or disapproval of the scheme. They are enough, however, to excite our inquisitive interest. The memorandum speaks of "highly trained technical personnel" who have been transferred from industry to the Services and of their replacement by "less highly qualified personnel" after a period of six months' "intensive training" at a technical college "in various branches of engineering." What, we may reasonably ask, was the nature of the work of the highly trained technical personnel whom the Committee has it in mind to replace by the less highly qualified, intensively trained substitutes? Were they skilled mechanics, leading hands, foremen, under-managers, or managers? We know that industry has lost to the Services many men of these categories, but we cannot believe that the Committee contemplates the possibility of replacing them by taking the steps outlined in the memorandum. The ability to fill these positions satisfactorily comes from years of practical workshop experience, and is not to be acquired by means of a six months' course of instruction at a technical college. Even although that were not so, the age of the trainees would for the most part unfit them for immediate promotion to positions of major or minor authority. Although express provision is made for the selection of others, it is quite evidently the intention of the Committee that the main body of the trainees should be young men, if not mere youths. The qualifications for selection named in the memorandum are such that an apprentice in his second year could qualify for training under the scheme. Doubtlessly, those charged with the duty of selecting the candidates for training may be trusted to see to it that no such abuse of the scheme will be permitted. Nevertheless, the terms of the memorandum clearly favour the selection for training of young men. What posts after six months' intensive training in various branches of engineering will these young men be capable of filling? They *might* be of service as junior draughtsmen or research assistants. The known shortage of men in these categories is, however, neither sufficiently great nor sufficiently restrictive to our war effort to justify the magnitude of the scheme outlined in the memorandum. It would have been of considerable assistance if the Committee had indicated the nature of the curricula which it proposes the trainees should follow. The farthest the memorandum goes in that direction is to indicate against each college named in its list the nature of the courses of instruction available at it, classifying them under six general headings, namely, mechanical, electrical, automobile, aeronautical, and production engineering, and naval architecture. If the object of the scheme is to give, within a space of six months, a general knowledge of the principles of one or other of these branches of engineering, then we are as far off as ever from understanding what posts the trainees on returning to industry will be expected to fill. Is it possible that the Committee impressed with the success with which men and women with no previous technical experience can be trained within a few weeks as machine minders, welders, painters, and fitters' mates, believe that engineers, in the wide and general acceptance of that term, can be similarly produced in a short space of time?

We await some further explanation of the Committee's proposals with interest, and with a certain amount of uneasiness. Meanwhile, two broad aspects of the scheme appear to us to demand immediate attention. In the first place, the very fact that the scheme has had to be proposed at all seems to be a reflection on the manner in which the problem of meeting the contending claims of industry and the Services for trained technical personnel has so far been tackled. Highly trained technical men have been withdrawn from industry and transferred to the Services. To replace them it is now intended to train intensively a large number of less qualified and generally speaking younger men. If the scheme is not to be reduced to something like an absurdity, the trainees on returning to the works will have to be protected from being called up for service with the Armed Forces. Had a similar protection been given to the highly trained technical personnel in the first instance the problem which the Committee is endeavouring to solve would not have arisen, or at least not in its present acute form. As matters now stand, the reasonable procedure to follow would, we feel, be to train intensively and along specialised lines suitable young men withdrawn from industry and at the end of their course to draft them to the Services in order to release as many as possible of the highly trained older men already taken and permit them to return to industry. In the second place, looking ahead to the days which will follow the conclusion of the war, we can foresee the development of

an unhappy situation in which the highly trained men demobilised from the Services will find their former places in industry occupied by the men trained under the Committee's scheme. Our sympathies will extend to both classes, to those who often at considerable sacrifice have had to leave their posts in industry to serve in technical capacities with the Armed Forces and to those who, assisted by the Committee's scheme, have been advanced to take the vacant places in industry. It would be optimistic beyond all reason and experience to expect—even taking into account the obligations imposed on employers by the National Service (Armed Forces) Act of 1939—that industry after the war will be able to absorb all in each category.

Wartime Transport

In the 1914–18 war it was our command of the sea, maintained, though in 1917 only just maintained, in face of an unprecedented U-boat campaign that, not merely by depriving the enemy of vital war commodities, but by making possible the munitioning and feeding of great armies distant from our shores and other centres of production, made victory certain. In the present war, despite the fact that we have no great Army on the Continent, sea transport has assumed an importance even greater than before. For the power of armies in the field is no longer to be reckoned in terms of man power alone, but by the numbers of tanks, aircraft and guns with which they can be supplied, whilst in action fuel and munitions can be expended at a rate unheard of in 1914. It is sea transport that brings us supplies from America, that sustains and builds up our growing armies of the Middle East; that carries warlike stores to Archangel to support the Russians and delivers them to the Persian ports. Far away, further east, there is, too, Singapore to be munitioned and fed against the threat of Japanese aggression. So widespread are the demands for shipping that it is little to be wondered at that Mr. Churchill recently referred, not to 1942, but to 1943 as the year in which enough shipping would be available to "enable oversea operations to take place utterly beyond British resources at the present time."

But the goods carried by sea must originate on land and even in so small an island as ours, of which no part lies more than 100 miles from the sea, the needs of inland transport of war commodities must be predominant to other needs if adequate use is to be made of our sea power. On Wednesday of last week Lord Leathers, Minister of War Transport, gave a review at a luncheon of the Institute of Transport of the present position of our transport industry and spoke of the co-ordination of its different branches and of the further steps now being taken to make unification of control more complete and the movement of goods more speedy. Passenger main line services on our railways have already been reduced 25 per cent. in frequency and further restriction is foreshadowed in favour of goods and special military trains. By the merging some time ago of the Ministries of Shipping and Transport the new Ministry is able to plan and supervise the movement of all goods to and from ships' holds, from manufacturer or to consumer without troublesome overlapping of responsibilities. There has resulted a quicker "turn-round" of ships in harbours. The Ministry recently announced a campaign for a corresponding quicker "turn-round" of railway wagons and road lorries, and the Government is to take over control of some 4000 road vehicles and has arranged for road hauliers to form, in addition, a reserve pool of vehicles available, if required, for use at short notice. Canals have not been neglected. Six Regional Committees have been reconstituted and their work is co-ordinated by a Central Canal Committee. Transport on our inland waterways is now, it appears, limited as much by the difficulty of finding crews as by any other factor. In fact, the actions of the Government, combined with the merging of the Shipping and Transport Ministries, have brought about much of that "systematic division of traffic between the four branches of transport," and that central control to "plan the best use of transport and the allocation of traffic in advance of the occurrence of a serious emergency," that the Committee of the Transport Advisory Council—whose advice was rejected at that time—recommended in a report to the Minister of Transport in May, 1940.

In our issue of October 24th we discussed in these columns the position of transport after the war. Lord Leathers reiterated our own conclusions. "Much of what is happening in home transport to-day, necessitating, as it does, a sensible working together of rail, road and water carriage, should prove useful in planning for a sound system of national transport in the future." But though that conclusion cannot be denied, there is, too, much in the wartime organisation of the industry that its separate sections could not but regard as objectionable were they maintained in peace. The Transport Advisory Council, for instance, advised in 1940 that the division of traffic "should normally be effected by voluntary allocation of traffic by mutual agreement between the four branches of transport," whereas at the present time it is the Government very largely that makes the decision. Nor can the road section of the industry be expected to welcome the intrusion of the Government in the guise of a great road haulier in control of 4000 vehicles. Wisely, therefore, the industry casts its thoughts ahead to consider what it would and would not be beneficial to retain out of the wartime organisation as soon as peace returns. In the meantime Government control is willingly borne in the interest of winning that victory without which all plans for the future must inevitably be worthless.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PEACE AIMS

Sir,—May I refer, briefly if possible, to some of the points mentioned by those who have written regarding my letter which appeared in your issue of September 12th?

The first letter was signed by some shy person who wrote under the *nom-de-plume* "Orthodocian," and in his first three lines he makes a great mistake.

I have never stated that if there were any amount of money there would be no unemployment. What I have stated is that if the financial system were modified as the march of events will doubtless compel us to do, each would have sufficient money to ensure that their absolute needs would be adequately met. This is quite different from stating that there will be no unemployment.

With a greater use of machinery there is bound to be insufficient work for every potential worker after the war damage has been made good, and after everybody has been supplied with the minimum necessaries which will be possible of attainment under this new financial system.

The next point raised by "Orthodocian" is to suggest that any system by which consumer credit is issued must lead to inflation. As this point has been raised by others in private correspondence which I have received, I am dealing with this more fully a little bit later in this letter.

The example of the bank and a new building which this writer quotes is not really convincing. What appears wrong is that the bank by virtue of a costless issue of credit to the builder of that house claims to be the owner of that house or of its equivalent in value. The country is richer by the erection of that building, and for that purpose more money should be available. It should not, however, be issued as a debt to any financial institution upon which interest is to be collected.

Further down, our friend suggests that I am relying upon man's willingness to work without inducement in the form of reward in cash. That is a misstatement. Under the scheme which Major Douglas has propounded all would receive a national dividend by virtue of their being nationals of this great country, and, in addition to that, they would be free to earn as much as their services in the field of their choosing would merit. If an increasing number of people decided to fold their hands and be satisfied with the standard of living obtainable from their national dividend, then the amount of the national dividend would be gradually reduced.

It is impossible in a letter to detail all the steps and precautions that would be taken, but it may be said briefly that there would be no fund from which the national dividends would be paid if people did not produce the goods and services, and therefore any undue number of people refusing to work would cause a reduction of the dividend.

The letter from Mr. M. J. Watt puts forward a technique with which I am quite familiar, having known Mr. Watt and his colleagues for many years. Mr. Watt suggests that the experts whose business it is to deal with such matters should be told of the objects which their system of economy must produce. Should they fail to achieve the indicated results, then these experts would be replaced by another group who would be given the same objective. I would like to suggest to Mr. Watt that before you can get a sufficient number of voters to tell the experts *viâ* Parliament what is required of them, you have to satisfy many more people that the attainment of the indicated objective is possible.

It is agreed by all that there is no physical reason why a very much higher standard of living could not be maintained. We have the ability and personnel to make all the necessary goods, to supply all the necessary services, but we are prevented from doing so by the absurd bogey that we cannot afford it. Very many

people believe that such a state of affairs would be too good to be true, and it is with the object of getting more people to understand that this desirable state is really attainable now that Mr. Watt and many others have been doing everything possible to demonstrate that this higher standard of living can now be experienced.

Mr. Watt's policy contemplates the replacement of the "experts" who have failed to produce the results by others. Surely those now in control of our finances have had their opportunity and have failed hopelessly to "produce the goods." Is it not time that they should be replaced by others who are not so hide-bound, by others who can contemplate the issue of consumer credit without shuddering?

The first point in Mr. W. H. Sayers' letter calling for comment is the statement in his third paragraph that the banks have carried on the "business of credit manipulation very satisfactorily." It depends entirely on one's view-point. From the aspect of those who are able to control the policy of the banks, their action has been highly satisfactory. If it is known in advance that inflation or deflation, even on a modest scale, is to take place, that knowledge will prove very valuable indeed to its possessors. But those who have not this pre-knowledge of coming changes cannot regard their position as satisfactory. If deflation has been arranged—and deflation has never yet occurred that was not deliberately organised by somebody in the upper realms of finance—then those initiators can sell their stocks and shares at the market price. When they decide that deflation has gone sufficiently far, they can buy back at lower prices, thus increasing their holding in various concerns whose shares they have purchased. That is very satisfactory to those people, but not to the rest of us—the lambs!

It is not clear that it is in the banks' interests that the community in which they operate shall be as prosperous as possible. The American depression of 1929 was deliberately caused because the financial big-wigs had come to the conclusion that the people were getting too prosperous and were paying off their indebtedness to the banks.

Manufacturers are very desirous that prices should remain stable. They enter into a contract to manufacture certain goods which will not be completed until after the lapse of several months. If during that time the price of materials rises, then they stand to lose over the contract. The regulation by the Central Bank of the volume of credit available to the community should be done with the object of maintaining stability of prices, but Mr. Montagu Norman has stated that, according to his experience, no Central Bank ever considered that the issue and withdrawal of credit should be controlled with the object of stabilising prices. Their main object has been to stabilise the exchange values of their country's currencies regardless of the internal value as expressed in goods and services.

Mr. Sayers, further down his letter, suggests that the National Credit Office would not be dependent for its own existence upon the highest possible level of prosperity in the country. This is hardly correct, as the National Credit Office would only have funds to distribute and functions to perform if the assets of the country were increasing, *i.e.*, if the country was producing more than it was consuming. Surely this condition will only obtain if the country is prosperous, just as a limited liability company is only prosperous if at the end of the year it has produced more than it has consumed, and the excess is available in the form of cash or credit for distribution to its shareholders. The shareholders of the National Credit Office would be the whole population entitled to receive a national dividend. In any case the National Credit Office would not be a profit-earning concern any more than is the judiciary or the Import Duty Advisory Committee.

The letter from Mr. Hugh P. Vowles hardly makes any reference either to Colonel Kitson Clark's articles or to my letter, but deals almost entirely with points raised by "Orthodocian" and indicates some of the ways which cause the purchasing power to become insufficient to buy all the goods that are produced.

I would like to assure Mr. A. Shepherd that the importance of maintaining the exchange value of our currency is well known as some commodities must be imported. Space does not permit a full discussion of the steps that would be necessary to maintain a stable exchange.

Mr. Shepherd then goes on to state that it would be impossible to adopt any system involving the issue of consumer credit, even if based upon actual production, unless a large block of nations adopted such a system simultaneously. That is, indeed, a policy of despair. It is sufficiently difficult already to secure any change in the financial system of single countries, but if such an attack would only be successful in one country provided it were also successful in several others, then indeed the position would be hopeless. One of the main objects of the Federal Union proposals, as I read them, is to stabilise present financial methods by making nations no longer autonomous in financial matters. A country that is autonomous, as we are, has the power and ability to control its own finances entirely. At one time it would have been thought impossible for a first-class industrial country to depart from the gold standard without incurring tremendous disabilities. Great Britain went off the gold standard in 1931, and instead of suffering as a result, circumstances improved enormously, and ultimately many other countries have followed our example, in fact, if not always in words.

Such would again be the case if we were to tackle this thorny question and recognise that our troubles arise, not so much from maldistribution of purchasing power as from an actual shortage of it.

Even if the present volume of purchasing power were redistributed in accordance with different suggestions that have been made, each would have so little that the standard of living throughout the country would be reduced, and greater unemployment would result, as no one would then be in a position to employ, but all would be seeking employment themselves.

Perhaps the most important point that has been raised in this discussion, both as published and as received privately, has been the charge that any issue of consumer credit freed from any obligation to repay would inevitably result in inflation. It is, therefore, worth while to devote attention to examination of this question. I propose to do so in a subsequent letter.

I. V. Robinson.

Walton-on-Thames, November 12th.

LOCOMOTIVE WHEEL NOTATION

Sir,—The usual method of denoting locomotive wheel arrangement seems capable of improvement; it is not sufficiently definite. The "Whyte" method, in which the driving wheels are indicated alphabetically, is more informative, and it is curious why it is not more used. But both ignore the booster. Why treat this valuable auxiliary so slightingly? May I suggest an amendment? A "Hudson" would remain a 2–C–2, but if booster-equipped would become a 2–C–(1–1a). This may look a little algebraic, but at all events makes things clear.

The "Whyte" method can be used for unusual wheel arrangements, and is still indicative. L.N.E.R. "No. 10,000"—sometimes called a 4–6–4, which is incorrect—would be a 2–C–1–1. Going back into history for an extreme case, a Webb "Greater Britain"—under the common formula 1–1–1–1, which tells you next to nothing—becomes a 1–A–A–1, and gives the facts. An American "Consolidation" with a four-coupled booster tender would be indicated by 1–D–O+T (2a)–2, and so on, but perhaps this way madness lies!

Edward H. Livesay.

Victoria, B.C., October 15th.

A REQUEST FOR FATIGUE INFORMATION

Sir,—For some time I have been searching for any published references, however slender, to a particular outlook upon fatigue and the fatigue limit which seems good to me, although I cannot discover whether the same or similar ideas have already been considered and abandoned.

Possibly some of your readers would greatly oblige by supplying references to any publication which may have been made on the following or on similar suggestions, or by expressing views on the following:—(*a*) If any stress measurement from the tensile test is used as a criterion of strength at the fatigue limit, it must surely be the true tensile breaking stress, not the U.T.S., which we are prone to dwell on so much in this connection; (*b*) the fatigue limit of a ductile metal should prove to be practically one-third of the true tensile breaking stress if the metal and the specimen are quite perfect, and progressively less than this as imperfections are more numerous and dangerous; (*c*) owing to imperfections, only the fatigue limit obtained in the wrong way (by raising stress-range gradually) should be practically one-third of the true tensile breaking stress; (*d*) an inductile metal will not exhibit the above relationship because the fatigue fully strain-strengthened stress is practically of the same value as the true tensile breaking stress in the case of the ductile metals only, differing greatly from the latter, on account of the fatigue high loading speed, in the case of the inductile metals.

Alternatively, publication references to the chief work of research on the dynamic loading of metals would be very welcome, for they seem to be difficult to find.

A. C. Vivian, D.Sc.

Bedford, November 14th.

Air Raid Precaution Measures and the Engineering Industry.—With the co-operation of the Ministry of Home Security (Research and Experiments Department) the Institutions of Civil Engineers, Mechanical Engineers, and Electrical Engineers have arranged a special whole-day meeting on Tuesday, December 9th, for discussions of different aspects of air raid precaution measures and the engineering industry. Senior officers of the Ministry of Home Security (Research and Experiments Department) will present to corporate members of the three institutions information and experience they have accumulated in their respective sections, and opportunity will be afforded for questions to be raised on the subject-matter. The specific subjects detailed for consideration at the several sessions are as follows:—Morning session: Introductory remarks, R. E. Stradling, D.Sc., Ph.D.; "The Effect of High Explosives on Structures," Professor J. D. Bernal, M.A., F.R.S. Afternoon sessions: "The Design of Protective Structures and the Defence of Industry," Professor J. F. Baker, M.A., Sc.D., D.Sc.; "A Survey of the Gas Contamination Problem in the Engineering Industry, with Special Reference to Electrical Machinery," Major J. W. Martin, B.Sc., A.I.C. The proceedings will not be printed or published. It has been found necessary to restrict admission to corporate members only of the three institutions, and to issue non-transferable tickets in response to written applications.

Development of "Bristol" Aircraft Gun Turrets

ONE of the first aeroplanes to be fitted with an enclosed gun turret, necessary for the protection of the gunner from the air flow at high speeds, was a "Bristol" machine, known as type 120, which was developed in 1930 and 1931. In this case the turret was mechanically operated. The first "Bristol" hydraulically operated power-driven gun turret was developed in 1935 and fitted in the nose of the "Bombay" bomber transport; and the first "Bristol" power-operated gun turret to be located amidships was fitted to the "Blenheim." These turrets proved of great value from the very first, enabling the air gunner to aim and fire steadily and accurately on the beam when flying at high operational speeds.

But the successful development of the power-driven gun turret depended in the first place on

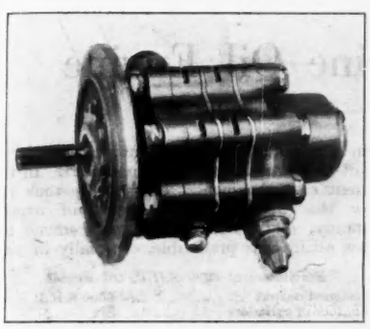


FIG. 1—HIGH-PRESSURE PUMP

the equally important development of the successful hydraulic system, which should be simple, reliable, and, above all, light in weight. The advantages claimed for the "Bristol" hydraulic system are greater flexibility of control, a quick yet smooth reversal of motion without shock, a useful "slip" for overloads or obstruction, an easily convenient location of transmission members, and the use of relief or control valves to safeguard against overloading. This hydraulic system was developed in 1935, in a research department specially devoted to the purpose. Unit testing was undertaken of such items as pumps, control valves, undercarriage jacks or "rams," and flap controls, &c. The most important development, however, resulted from prolonged and active research into the design of suitable hydraulic pumps, as the existing types suffered from the drawbacks of insufficient capacity and pressure to be suitable for the requirements of high-performance aircraft. The plunger type of pump suffered from violent fluctuation of pressure, which caused breakages; so that either the vane type had to be employed with

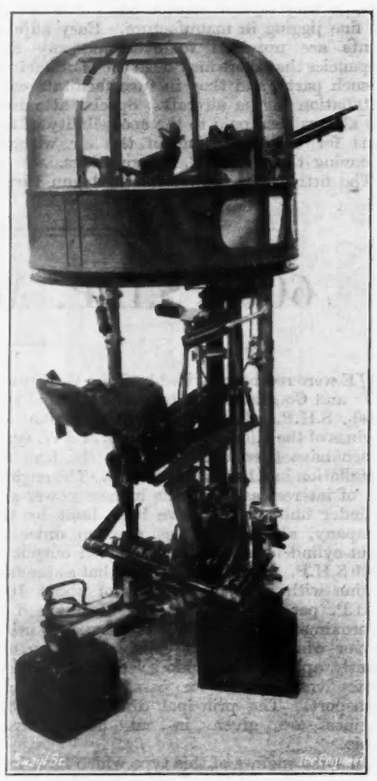


FIG. 3—TURRET WITH LEWIS GUN

its considerable limitations for high pressures, or else the gear pump, in which the faults were that it was difficult to get clearances sufficiently fine to reduce the "slip," and when they were obtained there was a resulting tendency to seize up. The first "Bristol" pump—Fig. 2—was tested early in 1936. It was a multi-stage gear pump, which stepped up the pressure very considerably.

Realising that existing types of gear pump would only work satisfactorily up to a pressure of about 300 lb. per square inch, several such pumps were placed in series. To ensure a full supply of oil to each it was arranged that the output from each unit should be theoretically in excess of the requirements for the succeeding stage. To control the output from each section a small adjustable relief valve was introduced between the stages. This design has since been developed to the extent of producing a practical three-stage hydraulic pump which will give pressures of 1500 lb. per square inch or more, with a flow of 6 gallons per minute at normal engine revolutions—Fig. 2.

The modern pump has three stages, the main

FIG. 5—TWIN GUN TURRET

production version covering a range of pressures up to 1200 lb. per square inch, with a delivery up to 180 gallons per hour. Actually this unit is known in the industry as the B.H. integral type, though it is built under "Bristol" patents. The first of these pumps to be type tested completed a hundred hours' test satisfactorily in February, 1936. It is claimed to have been the first successful hydraulic pump to meet aircraft requirements, and it is now being produced in very large numbers by sub-contractors. These hydraulic pumps form part of the back cover auxiliary equipment for all types of aero-engines, water-cooled and air-cooled radial types, British and American.

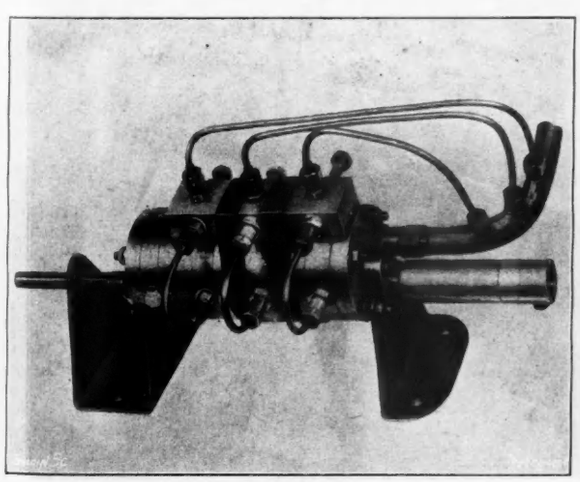


FIG. 2—MULTI-STAGE GEAR PUMP OF 1936

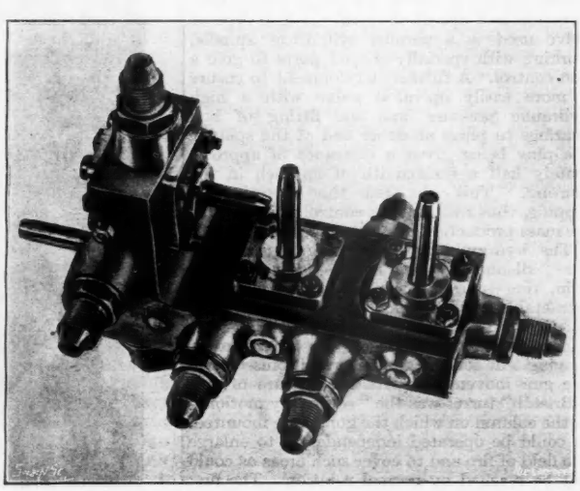


FIG. 4—CONTROL VALVE

The " Bristol " hydraulic system is operated as an open system, thus obviating the use of a " recuperator " or supplementary air pressure, which is necessary with a " closed system," involving, as it does, the use of auxiliary pumps operated either by hand or by motor.

The development of the " Bristol " gun turret provides a rather dry record of long and concentrated research. Electric motors and gears were first considered for providing the necessary power, but they were not then developed. In 1935 the vane type oil motor for operating the rotation of the gun turret was tested out very completely and eventually found unsuitable for the pressures required owing to the impossibility of making a strong enough cover for the motor. It was therefore abandoned, and jacks or " rams " were decided on for limited angular movements and a multi-cylinder motor for complete rotation as the best and most reliable operating mechanism, though the vane type motor at the comparatively low pressure of only 300 lb. is still used by other designers. The first " Bristol " turret was on test early in

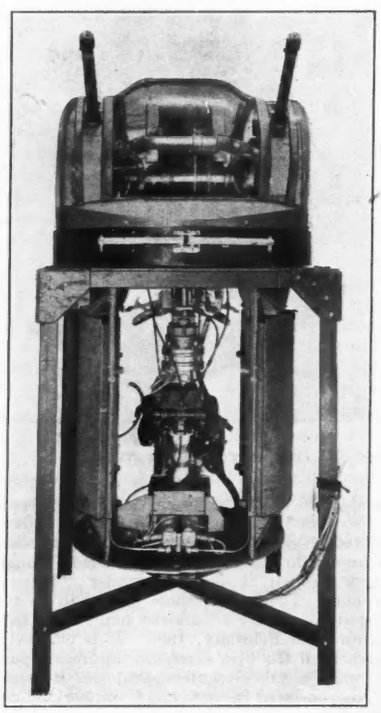


FIG. 6—TWIN GUN TURRET

1936, and it led to the development of suitable control valves which are simple in design, construction and operation—Fig. 4. The type of valve used is a parallel cylindrical spindle, working with specially shaped ports to give a fine control. A further development to ensure a more easily operated valve with a high hydraulic pressure was the fitting of ball bearings to plugs at either end of the spindle, the plug being given a clearance of approximately half a thousandth of an inch in the housing. This obviated the necessity of lapping, thus making this control unit suitable for mass production by sub-contractors.

The hydraulically operated gun turret on the " Blenheim " was small—having only a 30in. ring—and it was housed in a low-drag retractable cupola which was operated mechanically. The low drag of the " Bristol " cupola was attained largely by the use of a moving seat for the gunner, synchronised with the gun movement. Another feature of this " Bristol " turret was the " secondary motion " of the column on which the guns were mounted. It could be operated independently to enlarge the field of fire and to cover such areas as could not be reached by normal rotation. The first " Blenheim " turret was fitted with one Lewis gun—Fig. 3—and later with the Vickers G.O. or " gas-operated " gun. This turret was then developed for twin Browning guns, with which it is fitted to-day—Figs. 5 and 6. The design was such that it could be manufactured with ordinary engineering plant without requiring unduly skilled labour. It was probably the only turret in the early days that could be sub-contracted and built straight from the drawings, while the hydraulic system could be serviced by the ordinary R.A.F. personnel in the Service without " sending for the makers."

The simplicity of the modern design, it is claimed, lends itself not only to comparatively low cost of manufacture, but what is even more important, the interchangeability of parts, because they do not involve fine limits or call for fine jigging in manufacture. Easy adjustments are provided to overcome any discrepancies that there may be in the manufacture of such parts, and they in turn facilitate easy installation in the aircraft. Special attention has always been paid to the accessibility of the guns for easy servicing in the air without removing them from their mountings.

The fitting of a power-operated gun turret amidships in the fuselage involved the problem of a simple and efficient " fire cut-out," as well as " gun restrictor gears " to avoid shooting off the tailplane, fin, wireless masts or airscrew discs, &c., or fouling the fuselage itself. The " Bristol " turret, it is claimed, was the first to be provided with a compensator for rotational speeds on the " fire cut-out " mechanism. It ensures that a minimum of " cut-out cover " is provided for slow operational speeds of rotation, the cut-out cover being automatically increased in proportion to the increased speed of rotation.

A special gun mounting incorporating a " harmonisation gear " and a shock absorber system incorporated with a quick-release mechanism has been developed. The " harmonisation gear " is very simple and enables four guns to be lined up quickly and independently on the target. The quick-release device enables the guns to be removed at the touch of a lever and to be as easily replaced without handling anything but the gun, which becomes automatically locked in position when it is pushed home.

6000 S.H.P. Marine Oil Engine

WE were recently invited by John G. Kincaid and Co., Ltd., to attend the trials of two 6000 S.H.P. double-acting two-stroke oil engines of the Kincaid-Harland-B. and W. type, which have been constructed by the firm for installation in a British cargo ship. The engines are of interest as being the highest power six-cylinder units which have been built by the company, although it has now on order an eight-cylinder unit, with a designed output of 8000 S.H.P. It will be conceded that a standard engine with a normal output of about 1000 B.H.P. per cylinder, running at a speed of approximately 110 r.p.m., is a type of prime mover which should be capable of being efficiently applied to a wide selection of modern motor vessels both for passenger and cargo transport. The principal dimensions of the engines are given in an accompanying table.

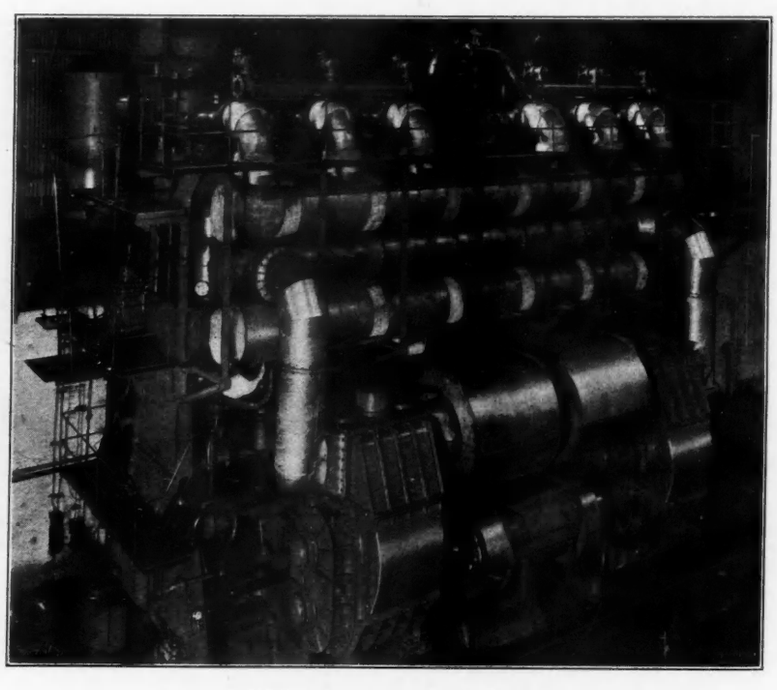
In some engines of this type which have been built a higher rate of output with a mean effective pressure of 96 lb. per square inch has been allowed, giving an output per cylinder of about 1120 B.H.P. at the same speed. In the present case the owners of the ship took the view that from the standpoint of overall economy, maintenance, and replacement the lower rating was preferable, especially in view of the owner's practice to operate their engines continuously at a speed and output close to the normal rating.

Particulars of 6000 S.H.P. Oil Engine

Designed output	6000 S.H.P.
Number of cylinders	Six
Diameter of cylinders	620 mm.
Piston stroke	1400 mm.
Piston speed	1000ft. per min.
Mean effective pressure (I.H.P.)	85 lb. per sq. in.

DESIGN AND CONSTRUCTION

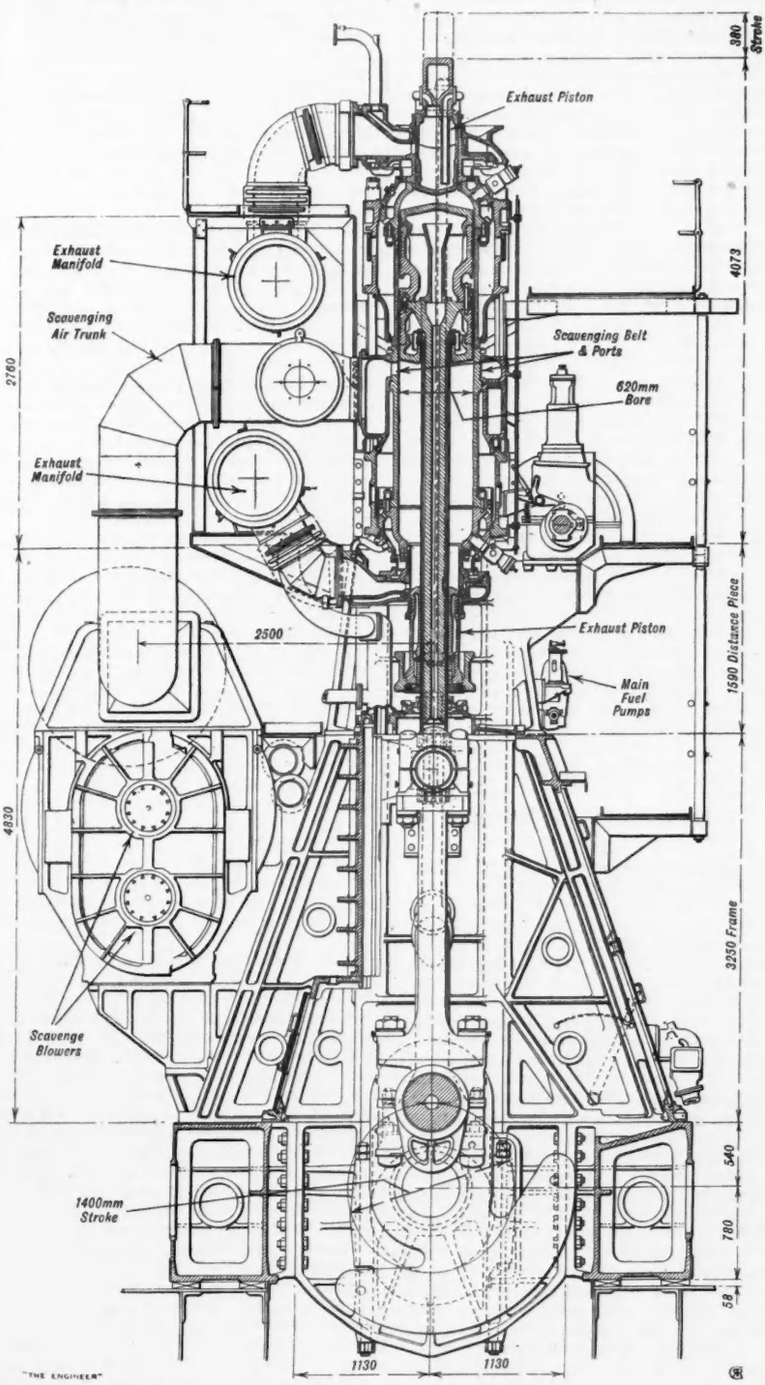
The accompanying drawing shows a section through one of the main cylinders, while the engraving illustrates the appearance of the engine on the test bed. In design the engine follows closely the normal construction of the



6000 S.H.P. MARINE OIL ENGINE

Harland-B. and W. double-acting two-stroke practice. The exhaust ports at the top and the bottom of the cylinder are uncovered by the outward movement of the exhaust pistons, while admission of the scavenge air is effected through the central belt of ports and is controlled by the movement of the main piston. The exhaust pistons are arranged 7 deg. in advance of the main pistons, so that the exhaust pressure falls quickly to the level of the scavenge air pressure, thereby ensuring excellent scavenging action. The diameter of the exhaust piston is about two-thirds of that of the main piston, and the coverless design with equal diameters of exhaust and main pistons has not been adopted in the present instance. The builders estimate that by the employment of exhaust pistons the power obtained from these pistons is about 10 per cent. of the normal output of the engine.

As will be seen from the drawing, and the left-hand side of the engraving, the fuel pumps are mounted on the front of the engine at second platform level. The pump plungers are driven directly from the camshaft, which carries cams with individual timing. There is a separate group of two pumps for each of the six engine cylinders, and one of these units supplies fuel to two fuel injection valves in the upper cover while the other serves the corresponding two fuel valves in the lower cover. In the top cover fuel valves there are three holes in the injection nozzle, each having a diameter of 0·88 mm., while the three holes in the bottom cover valves have each a diameter of 0·71 mm.



SECTION THROUGH 6000 S.H.P. OIL ENGINE

Fuel is delivered to the suction side of the main fuel pumps from a low-pressure pump, at a pressure of about 35 lb. per square inch, and the same pump is utilised for the oil for cooling the injection nozzles. The pressure at the discharge valves of the main pumps is such that the fuel reaches the valves at a working pressure of about 4500 lb. per square inch.

In order to provide for astern running there is a lost motion gear inserted in the drive from the camshaft, which ensures that the cams are automatically set in position for astern running. By this means a single cam is made to serve for both ahead and astern running.

The scavenge air is supplied by two blowers of the positive displacement type, which, as illustrated, are placed at the back of the engine. They are chain driven from the crankshaft, and a spring coupling type of shock absorber is included in the drive. The normal blower speed is about 2·6 times that of the engine speed. The scavenging air reaches the scavenging belt and ports at a pressure of slightly under 2 lb. per square inch, with the engine operating at normal output. As will be seen from the engraving, a delivery pipe from the upper end of the blower is connected to each end of the horizontal scavenge air trunk, which runs between the upper and lower exhaust manifolds.

The blower rotors run in plain bearings and the clearance of the rotor vanes is about ½ mm. For astern running the movement of the reversing lever actuates rods which operate change-over valves, reversing the inlet and discharge sides of the blower units.

Starting and Running Controls

The manœuvring of the engine is carried out by a single lever which controls both the starting air and the fuel. As already mentioned, there is a special gear for changing over the butterfly valves on the scavenging blowers and putting into the proper position the distributing cams for the starting air. For this purpose a centrifugal coupling and clutch, which takes up 120 deg. of lost motion on the camshaft, is provided. The movement of the starting and fuel control lever actuates pilot air valves, which allow the starting air to enter the main cylinders through the automatic starting valves which are arranged one in the top part of the cylinder and the other in the bottom part. The further movement of the starting and manœuvring lever controls the speed of the engine by increasing or decreasing the quantity of fuel delivered from the pumps. As shown by the sectional drawing of the cylinder, the main pistons are oil cooled, fresh water cooling being adopted for the cylinder covers and cylinder jackets.

At the time of the test bed runs and trials referred to one of the two engines was seen on test during the carrying out of its full-load and overload trials. It operated quietly and without incident, the absence of vibration at all powers up to 10 per cent. overload being particularly noteworthy. We may perhaps comment on the high quality of the workmanship, which no doubt plays its own part in the satisfactory running. The fuel consumption, we were informed, was about 0·365 lb. per B.H.P. hour, which is certainly a low figure, but is likely to be further lowered when the engine has been installed in the ship and run in. With regard to the lubricating oil consumption, it is of interest to record that the engine we are describing has been fitted with a new pattern of stuffing-box, which is said greatly to reduce the amount of lubricating oil used. With the new stuffing-box it is expected that in the twin-screw installation referred to, which has a designed output of 12,000 S.H.P., the amount of lubricating oil to be replaced daily should not exceed 12 gallons.

Sawdust to Yield Oxalic Acid.—Research by members of a section of the American Chemical Society, prompted by the war demand for oxalic acid, and the high prices obtained, has led to the possible industrial revival of a method, formerly exclusively used, for the manufacture of the acid by the fusion of sawdust with caustic soda. In an improved and continuous fusion apparatus, designed by the experimenters, runs have been made on six types of wood which showed that the yield of oxalic acid was dependent upon the cellulose content, although these yields were always higher, by a constant percentage, than the theoretical yield based on the results of fusion with pure cellulose.

Research and Development in Cast Irons*

THE work of the Association is almost wholly directed to assisting the war effort and activity throughout the year has been maintained at a high level.

The national situation calls for the fullest use of native iron ores, the most readily accessible of which are phosphoric, and this has resulted in three lines of approach to the more extended use in ironfounding of phosphoric iron. The first is the increased production and more extended use of refined irons made in part from phosphoric material. The second is the use of cast irons of phosphorus contents to the highest limits set by considerations of mechanical strength and soundness. The Association had in its earlier work already covered part of this ground, and it was completed, and a report issued on plain cast irons containing phosphorus through the Institution of Mechanical Engineers Research Committee on "High-duty Cast Irons for General Engineering Purposes." This report indicates the extent to which phosphorus can be used in irons required to comply with given national specifications. The same Committee has issued another report, prepared by the Association, on special-duty (austenitic and martensitic) cast irons for the information of engineers and designers. A further report is in preparation on phosphoric alloyed high-duty cast irons, in addition to a report on alloyed cast irons in general.

The third line of approach consists in the dephosphorisation of phosphoric pig and scrap. The basic steel process, as is well known, removes phosphorus from ferrous material, but only after the loss of silicon, manganese, and carbon present. The problem of removing phosphorus without eliminating carbon offers considerable technical difficulties, and much experimental work has been done during the year, and a report has been prepared. A great measure of success has been achieved on the necessarily small-scale trials, and the subject is now at the stage of justifying practical manufacturing-scale trials. The results show that phosphorus can be removed with comparatively slight reduction in carbon content. There is an accompanying slight loss of manganese and a considerable loss of silicon, the addition of which to dephosphorised metal would have to be made. Further developments depend upon the general situation. Trials have also been made of methods stated to dephosphorise, and have been shown to be either unsuccessful or commercially impracticable.

For the time being, the work done on cast irons containing very fine graphite structure has been postponed, but a group of reports has been prepared recording the stage reached, so that the subject can be taken up again at some future date. The possibilities of obtaining the fine graphite iron from the cupola are now much greater than they were, due to an increased understanding of the factors governing graphite formation.

Work on the determination of non-metallic inclusions in pig and cast iron has been continued. From the chemical side, three reports were presented by the Association to the Oxygen Sub-Committee and were included in the third report to the May Meeting of the Iron and Steel Institute. The methods evolved for use with pig and cast iron are now in final form, and are being applied to a representative series of British pig irons. From the microscopic standpoint, two reports were presented to the same meeting on the metallography of inclusions in pig and cast irons and on methods of preparing samples for examination. These papers were chosen for and evoked an excellent public discussion. Work on the properties of ingot mould material at ordinary and elevated temperatures continues, and the work carried out to extend the life of ingot moulds is of great service under present conditions.

The staff and laboratory concerned with moulding sands have been very fully engaged, since sand problems are as a rule prominent when new products are being made. Experimental work has continued on the reclamation of oil-bonded core sands and on substitutes for imported clays. Work is also in progress on foundry materials derived hitherto in the first place from imported food products.

For a large part of the year work on anti-glare continued at high pressure. As explained in the last report, the Anti-Glare Committee, of which the Director is Chairman, works in conjunction with the Ministry of Home Security for the purpose of assisting both the industry and the authorities in matters arising out of the defence regulations. The shortening of the black-out period, combined with the adoption of double Summer Time, greatly simplified the screening problem for many foundries, but in spite of this the Committee has approved of between 300 and 400 schemes. The number and variety of cases to be considered placed considerable strain on the staff concerned.

The demands of the war have been reflected in a great increase in the work both of this department and in the laboratories which serve both the research and development sides. The sands and refractories and microscopic laboratories both show increased output, while in the case of the chemical laboratory an increase of one-third, and in the mechanical testing laboratory an increase of one-fifth over the previous year is shown in the number of tests and determinations made. The last two mentioned laboratories have a load approximately twice as great as in 1939. The Scottish laboratory (Mr. T. Tyrie, B.Sc., superintendent) fully shared in these increases.

The items of the research programme concerned with the war effort have been mentioned above. The development department and the laboratories have been and are daily in contact with members on the technical aspects of the production of all components required in cast ferrous metal. Advice on the wider use of cast iron is contantly sought by and given to the official departments concerned, and advice sought and given on matters arising out of raw material supplies have greatly minimised the difficulties incidental to the present conditions under which the industry is working.

* Extract from the 20th Annual Report of the British Cast Iron Research Association.

Irrigation in India

IN the course of a lecture on the development of irrigation in India, before the Royal Society of Arts, on November 14th, Sir Bernard Darley, M. Inst. C.E., said that the Government had spent over £100,000,000 on canals throughout India. These canals irrigated annually some 30 million acres and the value of the crops raised by the help of the water was estimated at nearly £70 million annually. The Government did not seek a great return for the money expended; actually, the canals as a whole paid about 5 per cent. on the capital outlay after meeting expenses. The important factor was that they had banished famine and brought prosperity and contentment to the cultivator. As the years went on the benefits conferred by the canals would become more and more apparent as they were called upon to help to provide food for the ever-growing population.

Only a few works of any magnitude were constructed before the country came under British rule. Probably the oldest was the Cauvery delta system of canals, which were supplied from an ancient stone weir built some 1700 years ago. The first efforts of British engineers under the East India Company were directed towards the improvement of old indigenous work. The Western and Eastern Jumna canals were reopened in 1821 and 1830 respectively, and the old masonry weir across the Cauvery in Madras was replaced by a new weir with sluices, and the remodelled canals opened in 1838. The terrible famines which ravaged the country led to the rapid expansion of irrigation works both by the East India Company and, later, by the Government of India. During the Orissa famine of 1856–66 over a million people died, or about a quarter of the population. Starvation was the yearly dread of millions until canal systems and railways were built and serious famine banished from the land. Gradually the waters of every river in Northern India were harnessed and more and more land protected until, by 1920, only a few large schemes about which there had been considerable controversy remained to be executed. In Central and Southern India huge storage dams were constructed which held up the monsoon rainfall for use during the dry months of the year.

After the last Great War three huge canal projects were sanctioned. These were the Sukkur barrage canals in Sind, the Sutlej Valley canals in the Punjab and Bahawalpur and Bikaner States, and the Sarda canal in the United Provinces. After describing these works and other recent undertakings, such as the Mettur dam and the Haveli and Thal canals, Sir Bernard passed on to consider future developments. It would, he said, now be necessary to turn to new methods for any future development.

The first method that suggested itself was the tapping of the vast reservoirs of subsoil water by means of tube wells. A scheme of that nature was first undertaken some years ago near Amritza, in the Punjab, where a large fall on the upper Bari Doab was harnessed and the electrical power developed was run out to various tube wells in the surrounding country. A similar project, but on a much more extensive scale, had been undertaken of late years in the United Provinces. There a scheme costing over £2½ million was nearing completion. Several falls on the Upper Ganges canal had been harnessed and the electrical power developed was utilised both for light and industrial purposes in eighty-eight towns in the northern portions of the Provinces, and also for pumping water from Government and private tube wells. Some 1500 tube wells had been sunk by the Government. Thus nearly 600,000 acres were irrigated annually in areas which could not be given canal irrigation.

A scheme of some magnitude had also been undertaken in the United Provinces to pump water from the Gogra River, which lay too low to permit of flow irrigation in the ordinary manner. No doubt similar schemes would be undertaken elsewhere throughout India.

Another possible form of development was the further construction of storage dams to hold up monsoon rainfall. All the best sites in Central and Southern India had been utilised, but further works of that nature would no doubt be undertaken as the years went on. It was unfortunate that the rock of which the Himalayas were formed was so fissured that very few sites existed where high storage dams could be built.

One notable work had been projected in the Punjab. There a suitable site existed on the Sutlej River and various schemes had been prepared for a dam, which was known as the Bakra dam. Proposals for that dam varying from one 400ft. to one 500ft. high had been made with reservoirs above holding 80,000 to 120,000 million cubic feet of water. Unfortunately, the reservoir would submerge a very large area of Bilaspur Independent State, and the ruler had raised objections which it had not yet been possible to meet satisfactorily. The scheme would enable an area which had constantly suffered from drought and famine to receive the blessing of canal water.

Lastly, there was the question of making existing supplies go further. Only about 50 per cent. of the water entering a large canal reached the fields; the remainder was absorbed into the ground on the way or lost by evaporation. Extensive experiments were being made at present with various materials for lining canals to see if any cheap and efficient method could be devised which would check the leakage.

CAN RHODESIA PRODUCE MERCURY?—Deposits of cinnabar are being developed in the Bubi district of Southern Rhodesia with Government assistance under the Department of Mines and Public Works. At the end of 1940 prospects were considered to be sufficiently encouraging to warrant further assistance being granted. It is, however, too early to express any definite opinion about a fresh possible industry.

Colloidal Fuel*

By J. E. HEDRICK†

In 1879[6]‡ it was proposed that oil be mixed with pulverised coal in order to get a fuel cheaper than oil, but having many of its advantages. The work of Bates[1] in 1918 was the first important attempt at commercial utilisation. An effort was made then to develop colloidal fuel for use in submarines. After the first World War this work was dropped. During the last decade efforts in this direction have been renewed in Europe, but there has been almost no consideration of this fuel in the United States. Reports of the work already done are sketchy and cover a limited number of tests. The review by Manning and Taylor[4], however, is a most complete account of previous research.

Presumably the favourable features of colloidal fuel might be listed as follows :—

(1) It may be cheaper than oil.
(2) It may be handled like oil in pipes and pumps.
(3) Its burning efficiency should equal or exceed that of oil.
(4) It may enable better utilisation of storage space.
(5) It may permit conservation of our petroleum, or at least release more of it for more profitable markets.
(6) Its use would eliminate the danger of spontaneous combustion now present in coal storage.
(7) The ash and moisture content would be less than that of the coal, and the heat value on a volume basis higher than for either oil or coal.
(8) Its use should permit better utilisation of solid fuels such as low-rank bituminous, lignite, and cannel coals.

The most promising uses for colloidal fuel would naturally be those in which advantage could be taken of one or more of the features just mentioned. Outstanding examples are railway, diesel, and marine fuels, and in stationary power plants now using pulverised coal. It seems probable, too, that these oil-coal mixtures may have other important commercial uses than as fuel. Their use as a chemical raw material shows definite promise. The development of such a fuel does present technical problems, however, such as stability, flow through pipes, atomising, grinding the coal, and mixing the coal and oil.

Stability

A practical requirement for the satisfactory use of oil-coal fuels is that the coal remains in suspension. The degree of stability is dependent on many variables, the most important of which are size of the coal particles, viscosity of the oil, density of the coal and oil, and the electrostatic charges on the particles. When settling occurs, the coal packs tightly in the bottom of fuel tanks and other equipment. This settling does not follow Stoke's Law. The coal particles are of random size and shape, and they interfere with one another.

Stability may be produced by the addition of a third substance to the mixture. Many such addition agents can be used, but it is now recognised that there are three distinct types. These are emulsifiers, gel formers, and surface-active agents. With cracked residue fuel oils, because of their higher specific gravity and viscosity, no stabilising agent is necessary unless the fuel is heated to temperatures higher than 120 deg. Fah. Thus there is no stability problem in storage of the mixtures, but only in handling them where they must be heated before pumping and burning.

The preparation of ores by oil flotation is an excellent example of the use of an emulsion to produce a stable suspension. Experiments have been carried out on the stabilisation of coal particles in oil using water-in-oil emulsions. The particles are held in suspension by being entrained at the water-oil interface. The use of emulsions, however, is entirely impracticable. They are easily broken by heating or mechanical agitation, and they produce stability only with very small amounts of coal. Furthermore, the presence of the water would lower the heating value of the fuel.

Gels are produced by adding rubber, metallic soaps, and various fats and waxes to the oil. The function of these agents is to increase the viscosity. The trivalent aluminium soaps are more effective than the soaps of bivalent calcium, zinc, lead, and magnesium. From 1 to 5 per cent. of these soaps, based on the weight of the finished fuel, must be added to prepare stable suspensions. The use of soaps would be expensive and the increase in viscosity would make pumping more difficult. The gels are sensitive to temperature change. Due to the "stringiness" they impart to the fuel, satisfactory atomising at the burner tip is impossible.

When 0·05 to 0·2 per cent. by weight of the condensation product of a fatty acid is added to an oil-coal mixture, a stable suspension is produced. This is an agent of the surface-active type. The mechanism of stabilisation is not clearly understood, but it is known that a surface-active agent is selectively adsorbed on the surface of the coal particles and causes a lowering of the interfacial tension between the coal and the oil. Furthermore, it causes greater uniformity in the electrostatic charges on the coal particles.

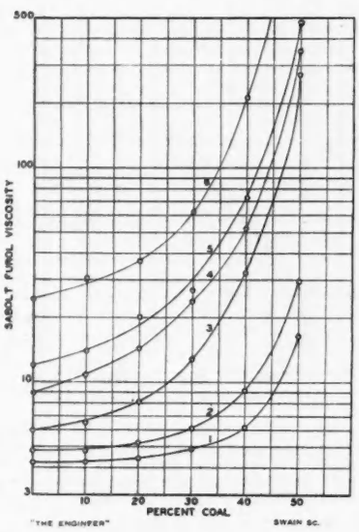


Fig. 1—*Effect of Coal Concentration on Viscosity at 210 deg. Fah.*

The charges on coal particles are presumably caused by the friction during grinding. Since coal is not a homogeneous material, both positive and negative charges exist, even on different areas of the same coal particles. The oil is such a poor conductor that these charges are neutralised slowly. This means that the agglomeration of the particles with resultant settling proceeds slowly but definitely. The addition of the surface-active agent produces negative charges on all the particles.

Surface-active agents do not increase the viscosity of the suspensions appreciably. They are effective over a wide temperature range, and they can be used with any petroleum fraction from petrol to the heaviest fuel oil. A study of the economics of colloidal fuel[3] limits stabiliser cost to approximately 50 cents per ton. It is believed that this cost can be met with a surface-active material, because of the small amount required.

Experiment has shown that coals of a size larger than 75 per cent. through 200 mesh are not satisfactory for making colloidal fuels. Larger sizes cannot be successfully stabilised. On the other hand, smaller sizes require much less stabiliser. Coal of about 98 per cent. through 200 mesh seems to be most desirable. Finer coal would be too costly to grind. These results are based on two samples of washed bituminous coal of 1·32 and 1·26 specific gravity respectively. Probably the results would be equally applicable with other similar coals.

Flow and Atomising

No property of oil-coal mixtures is more important than the viscosity. The oils for the most part from which colloidal fuels can be made are viscous, and the addition of coal to them increases the viscosity. This property is closely connected with the resistance of flow of these fuels in pipes and with the spraying from burner tips for efficient combustion.

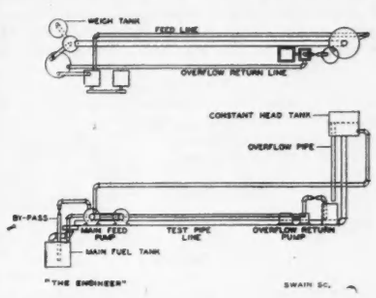


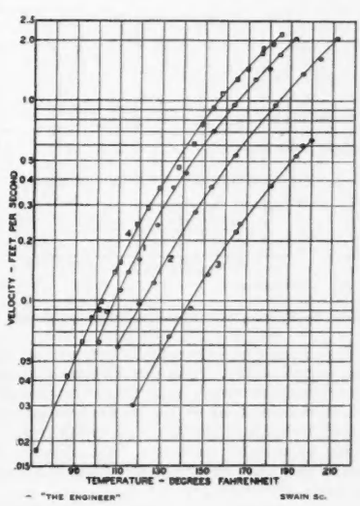
Fig. 2—*Diagram of Flow Equipment*

Oil-coal mixtures were prepared using six oils of widely varying gravities and viscosities. The physical properties of these oils are shown in Table I. The effect of the coal concentration (weight per cent.) on the viscosity of these mixtures at 210 deg. Fah. is shown in Fig. 1

Table I.—*Physical Properties of Oils used in Experimental Work*

	A.P.I. gravity, 60 deg. Fah.	Furol viscosity, 122 deg. Fah.
(1) Virgin gas oil ...	34·1	5·3*
(2) Cracked gas oil ...	29·5	7·3*
(3) Cracked residue fuel oil	8·5	18·5
(4) Ditto	12·0	54·7
(5) Ditto	10·9	112·7
(6) Ditto	4·8	318·0

* Extrapolated values.



(Curve 1, 10 per cent. coal ; curve 2, 20 per cent. coal curve 3, 30 per cent. coal ; curve 4, fuel oil)

Fig. 3—*Effect of Temperature on Flow of Fuels through 1in. Pipe*

The steep slope of the curves at the higher coal concentrations should be emphasised. When a mixture contains more than 50 per cent. coal it becomes a thick paste, which would not flow through pipes. There is a possibility, however, that such fuel pastes might be handled with a screw conveyor or some type of mechanical pusher. In general, the shape of these viscosity-

* American Society of Mechanical Engineers. June, 1941.

† Department of Chemical Engineering, Kansas State College, Manhattan, Kansas.

‡ These figures refer to Bibliography at end of paper.

concentration curves is the same at other temperatures.

Because of lack of information, a study has been made of the friction in pipes during the flow of these fuels. The equipment is shown diagrammatically in Fig. 2. The fuel was allowed to flow from a tank through a test line, 22ft. long, into a weighing tank. A constant head of 5ft. was maintained by means of an overflow pipe in the upper tank. A by-pass on the discharge end enabled the fuel to be recirculated and the overflow was also pumped back. Test lines from ¼in. to 3in. could be used interchangeably. Electric heaters controlled by adjustable thermostats could maintain any temperature substantially constant over the range 80 deg. to 200 deg. Fah. The oil used for

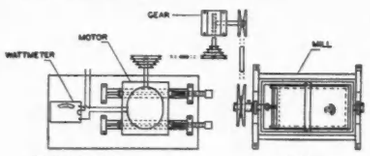


FIG. 4

these flow tests was a cracked residue having a viscosity of 203 Furol seconds at 122 deg. Fah. Both coal concentration and temperatures were varied.

The flow of colloidal fuels through pipes is well within the viscous range. Seldom will Reynolds numbers be as high as 500. Curves showing the effect of temperature on the velocity in a 1in. pipe are plotted in Fig. 3. Such curves are of considerable value in determining the temperature to which a fuel must be heated in order to get the required flow to the burner. Similar data for other pipe sizes are not yet complete.

This flow follows the Hagan-Poiseuille equation closely at low coal concentrations. There is some divergence with amounts of coal greater than 30 per cent., but the equation is sufficiently accurate for most calculations. The deviation

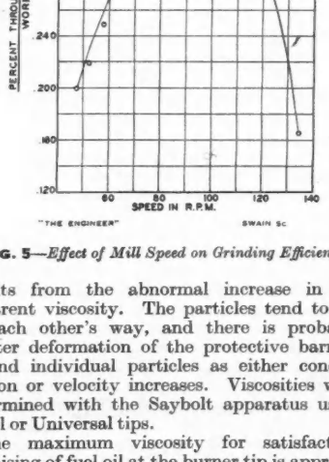


FIG. 5—*Effect of Mill Speed on Grinding Efficiency*

results from the abnormal increase in the apparent viscosity. The particles tend to get in each other's way, and there is probably greater deformation of the protective barriers around individual particles as either concentration or velocity increases. Viscosities were determined with the Saybolt apparatus using Furol or Universal tips.

The maximum viscosity for satisfactory atomising of fuel oil at the burner tip is approximately 40 Furol seconds[5]. On the basis of experimental tests it is concluded that the figure for colloidal fuels would be nearly the same. With a great many oil-coal mixtures this viscosity would be reached automatically, due to the temperature rise caused by the atomising steam and radiation from the fire-box. With others, preheating in the fuel ranks would be necessary.

Grinding and Mixing

The cost of grinding the coal is one of the most important considerations in the economics of colloidal fuel. This cost is a function of so many variables that it is difficult to predict what it would be for a given operation. Roller mills and ball mills are the types most commonly used for pulverised coal burners. The choice of mill probably lies between the two.

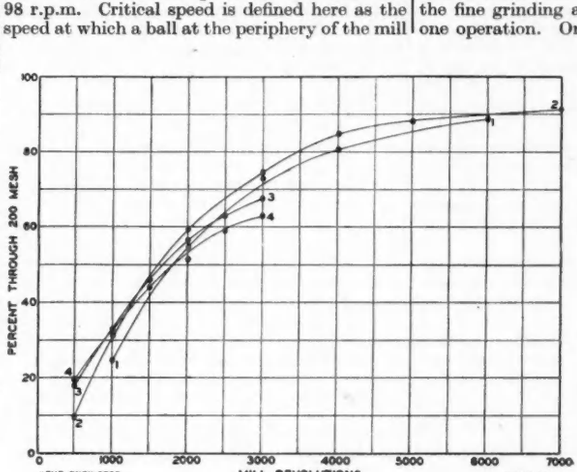
In this work studies have so far been confined to ball mill grinding. The mill was that used for the determination of A.S.T.M. ball mill grindability. It was driven by a ½ H.P. motor and equipped with a system of variable-speed pulleys. By mounting the motor on an adjustable platform the speed of the mill could be closely controlled up to speeds of more than 150 r.p.m. Power requirement was measured by a suitable watt meter and mill speed with a speed counter. The arrangement of this apparatus is shown in Fig. 4.

The speed of the mill has a pronounced effect on the grinding efficiency. Tests were conducted using a charge of 100 1in. steel balls and 500 grammes of coal of size −10 and +200 mesh. The critical speed for the mill was 98 r.p.m. Critical speed is defined here as the speed at which a ball at the periphery of the mill will just be held in place by centrifugal force. The optimum speed for maximum power input was 92 r.p.m. Results for two coals are shown in Fig. 5. The optimum is therefore about 94 per cent. of the critical. Both the optimum and the critical speeds vary with the mill diameter, but their relation to each other is not materially affected. An analysis of Fig. 5 leads to the conclusion that the distance the balls fall determines to a large extent the grinding efficiency and therefore that the bulk of grinding is by impact rather than by attrition.

The size and shape of the grinding media materially affect the grinding efficiency. Data are far from sufficient to form a general theory, but several observations are interesting. For a required coal size of 90 per cent. through 200 mesh, the ¼in. by ⅜in. rod gave the highest efficiency. For other sizes different media were more effective. In general, irregular shapes tend to prevent ball coatings which would otherwise lower efficiency. New balls are better than old or worn ones, and hollow balls are less effective than solid ones.

No study has been made of grinding aids. Their function is to keep the grinding media free from coatings. Ball coating is influenced by the moisture content of the coal. When the moisture is 2 per cent. or less there is no caking, but at 4 per cent. moisture this becomes appreciable. Finer coal, of course, cakes more readily. In most cases the media and grinding conditions can be adjusted so as to prevent the formation of ball coatings.

Mixed charges of media influence the amount of product of a definite size. The results with various ball charges are shown in Fig. 6. These data emphasise that greater amounts of a smaller size are produced by using smaller balls. However, this is true only when the feed is proportionately fine. A definite size of grinding media grinds most efficiently within a certain size range. Thus, mixed charges are often a distinct advantage, each size operating most efficiently on a different size of coal.



(Coal, −10, +200)

(Curve 1, 1000 grammes coal, 30 lb. ⅞in. steel balls; curve 2, 800 grammes coal, 22 lb. ⅞in. steel balls; curve 3, 800 grammes coal, 11 lb. 1in. steel balls and 11 lb. ⅞in. steel balls; curve 4, 800 grammes coal, 16 lb. 1in. steel balls and 6 lb. ⅞in. steel balls)

FIG. 6—*The Effect of Different Ball Charges on Grinding Efficiency*

A report on the ball mill grinding of ores by Coghill and De Vaney[2] contains much information of use. The capacity varies as the 2·6 power of the diameter and nearly directly with the length. Increasing the circulating load increases the efficiency and capacity of a definite size. Lighter feeding is better and the load should be just sufficient to fill the interstices of the balls at rest.

Much work must yet be done on coal grinding. The information available is much too general for accurate use. Feed rates, mill shapes, and classification have hardly been investigated at all. An interesting possibility also is that of grinding the coal in oil. The coal might be ground first in a disc mill to 16 mesh or finer, and then fed with the oil into a ball mill. Thus the fine grinding and mixing could be done in one operation. On the other hand, wet grinding would introduce complications in the way of fineness control, variations in dilution, and gumming up of the equipment.

A few cost figures for estimating purposes only are available. A ball mill or roller mill to produce 2–3 tons per hour of coal 90 per cent. through 200 mesh would cost approximately 20,000 dollars. Power requirements vary from 10 to 35 kW per ton and maintenance and labour costs based on actual installations range from 3 to 10 cents per ton. That these figures are indefinite is at once apparent.

No data are available on mixing oil and pulverised coal. Laboratory mixing of small samples has indicated that effective mixing would be difficult, since the materials are so viscous. It seems likely that mixing might be done more economically by heating the fuel to about 200 deg. Fah. to lower its viscosity. Sufficient consideration of this operation has been published elsewhere[3].

Conclusions

It is believed that the results of this work are sufficient to establish its commercial possibilities. The search for better and cheaper ways to produce stability must be continued. Much work still needs to be done on burning and atomising and the investigation of grinding and mixing has hardly more than begun.

Bibliography

[1] "Colloidal Fuel," by L. W. Bates, pamphlet privately printed, 1918.

[2] "Particle Size Reduction and Separation," by W. H. Coghill and F. D. De Vaney, "Transactions" of the American Institute of Chemical Engineers, 1938, Vol. 34, pages 113–129.

[3] "Can Oil-Coal Mixtures be Economically Developed?" by J. E. Hedrick, *Coal Age*, 1940, Vol. 45, No. 12, page 65.

[4] "Colloidal Fuel," by A. B. Manning and R. A. A. Taylor, "Transactions" of the Institution of Chemical Engineers, 1936, Vol. 14, pages 44–59.

[5] Private communication from C. F. McClure.

[6] "Liquid Fuels," by H. M. Munsell and H. R. Smith, U.S. Patent 219,181, September 2nd, 1879.

A Saw for Concrete.—An American company specialising in stone working machinery has designed and made a saw for cutting concrete. One model, fitted with a 14in. or 18in. abrasive wheel saw and operated at a speed of 2300 r.p.m., cuts an 8in. concrete joist in 1½ minutes. The wheels can be worn down to less than 8in. in diameter before discarding, and on a test one cut fifteen concrete joists with only ¼in. of wear.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Iron and Steel in the United States

The strike of the coal miners in those mines which are owned and worked entirely for the steel works has resulted in setting back the production of pig iron in the United States. A blast-furnace in the Birmingham and four in the Pittsburgh-Youngstown district were banked down. The miners afterwards returned to work for a period of nineteen days, during which negotiations for a settlement of the dispute will be pursued. The strike, however, broke out on November 17th. Following the truce three blast-furnaces in the Pittsburgh district resumed full operations. In this district, forty-one of the forty-seven furnaces remained active. It is unfortunate that stocks of fuel were not replenished after a similar strike earlier in the year. In several cases steel works have fuel supplies only sufficient for from two to eight weeks. Apart from the labour situation, the iron and steel industry seems to be working on steady lines. It is not expected that pig iron prices will be changed for the first quarter of 1942. The quotations, f.o.b. furnaces, are in the Birmingham district :—No. 2 foundry, 20·35 dollars; Bessemer, 25·00 dollars; basic, 19·00 dollars. These, of course, are domestic prices, and bear no relation to export quotations. A site has been cleared at Youngstown to build a new blast-furnace in place of one which was dismantled some years ago. The new furnace is expected to have a daily capacity of 1000 tons, and will be financed and owned by the Government, although it will be operated by the Republic Steel Corporation on a five years' lease. In the Chicago district and certain other points the situation is thought to be serious, and in some cases works in the West are understood to be operating on a day-to-day basis and largely depending upon local scrap-collecting schemes. Three open-hearth furnaces belonging to the Bethlehem Steel Corporation have been closed owing to a shortage of scrap. The annual capacity of the seven blast-furnaces totals 750,000 tons ingots. Against this, two new blast-furnaces, with a capacity of 800,000 tons per annum, have started operations. Scrap prices are fixed at :—No. 1 railroad selection, 21·00 dollars; scrap rails, 22·00 to 24·50 dollars; and dealers' selection heavy melting, 20·00 dollars. The steel output has been an average of 99·9 per cent. of ingot capacity, but as a result of the miners' strike has dropped to 80 to 95 per cent. It is claimed that the hoarding of steel is less prevalent, and although priority working is strictly enforced, the small consumers engaged on non-essential work have been able to obtain supplies.

The Pig Iron Market

The demand for pig iron is steady in practically all sections of the market, and the position is satisfactory, since the blast-furnaces are able to meet the demands of the consuming industries with regularity. Complaints heard during the first year of the war of delays in deliveries and difficulties of obtaining pig iron appear to be a thing of the past, although it is obvious that under present conditions users cannot expect always to obtain the exact grade or description of iron they would like. The hematite position remains rather tight, but it is reported that in some cases stocks have accumulated in makers' yards, and the Control, with an eye to the future, is carefully husbanding these accumulations. Consumers have become accustomed to using substitutes wherever possible, and the production of refined irons has been increased in order to meet the call for these descriptions for use instead of hematite iron. It is expected that the demands of the steel works will increase in the future, and it is understood that for this reason the Control does not permit the use of hematite except where it is necessary. The foundry trade is irregular and whilst the heavy engineering firms are busily employed and requiring considerable quantities of pig iron, the light castings sections of the industry have not much work in hand, and there seems little prospect of expansion in this direction. In consequence, the production of high-phosphoric pig iron is more than sufficient to meet the demand, and stocks are said to have accumulated at the blast-furnaces. Midland makers of high-phosphoric iron are supplying users in Scotland and on the North-East Coast. In the latter district the production of foundry iron has practically ceased, and attention is concentrated upon the production of basic iron for the steel works. In Scotland consumers are taking up considerable tonnages, but are finding supplies ample for their requirements. There is a steady demand for forge pig iron and the producers are well able to meet the demand.

The Midlands and South Wales

One of the satisfactory features of the Midlands steel industry is that, in spite of the curtailment of the American imports, supplies of home-produced billets and sheet bars to consumers have been well maintained. Most of the re-rolling works have been able to accumulate stocks of billets, and although these are now being drawn upon, the position, so far as can be seen, will remain satisfactory for several months. There is a brisk demand for the lighter sizes of structural steel, and the works are in full operation. The call for small bars is somewhat variable, and, whilst some works report full order books, others are in a position to accept more business. The sheet works are comfortably employed, but the pressure of the demand is not so heavy as a few months ago, notwithstanding that recently some good Government orders were placed. Delivery dates are reasonable, and consumers employed upon war work are receiving particular attention. There is an active business passing in cold rolled strip and bright drawn steel bars, and it seems that the producing works are likely to be well employed on these descriptions for a long time. The demand for plates shows little signs of relaxing, and considerable tonnages continue to pass to the shipyards, whilst tank makers and wagon and locomotive builders also provide a good outlet. The collieries are receiving large quantities of colliery material, and are in a comfortable position as regards supplies. The consumption of special and alloy steels appears to be increasing, but with the recent expansion in production the requirements of the consumers engaged upon war work are being adequately met. Steady conditions rule in the South Wales steel industry, but recently there has been a slight increase in the demand for billets. Business in sheet and tin-plate bars, however, is on the quiet side, as a result of the reduced production of sheets and tinplates. The heavy steel works are operating at capacity, principally on orders arising from the war.

North-East Coast and Yorkshire

Whilst some observers believe that the pressure of demand upon the heavy steel works on the North-East Coast is not so insistent as a few months ago, it is sufficient to keep the works fully employed. Most of the steel works have enough orders in hand to keep them busy well into 1942, and if there is any slackening in consumers' requirements it is probably of a temporary character. It is true that the demand for heavy joists and sections has never entirely recovered from the falling-off in the demand in the early part of the year, but lately a revival of business in this department has been noticeable. The call for the lighter sections has been maintained practically the whole year, and re-rollers are experiencing a steady request for light sections, small bars, and strip. Pressure upon the re-rolling industry is reflected in an active demand for billets, and in spite of the reduction in American imports of this class of material, home consumption, plus stocks which have been accumulated, have proved sufficient to keep the works employed without any disturbance to outputs. Perhaps the plate section of the market is the busiest, and there has been no slackening in the demand for plates of all thicknesses. The requirements of the shipyards continue heavy, and big tonnages are passing to that industry, whilst boilermakers, locomotive builders, and wagon builders are also providing a steady and important outlet for the plate mills. The position of the sheet works has improved and the mills are assured of busy conditions until the end of the year. The demand is equally good for both black and galvanised sheets, and most of the work in hand is of a priority category. Of late there has been a noticeable expansion in consumers' requirements of alloy steels. This is largely due to the increased demands of the armaments and munition makers, but a large tonnage is also required by engineers engaged upon other war work. The production of this class of steel has been considerably increased since the war began, and consumers' requirements are being satisfactorily met. The Yorkshire steel industry is experiencing a strong demand for practically all descriptions of finished steel. The sharp increase in the requirements of alloy and special steels has resulted in a certain amount of reorganisation, and a few firms have been instructed to concentrate exclusively on the production of these steels. The demands of the collieries are being met, although these have shown a tendency to increase. There is a sharp request for roofing bars, arches and light rails; but supplies appear adequate.

Copper and Tin

The copper position shows no material change from that which existed during the past few weeks. In Great Britain the heavy demand for war purposes is, if anything, increasing as the effort becomes more intensified. The Control is carefully supervising the issue of licences and there has been some further curtailment of quantities of copper permitted to firms employed on civilian work. For instance, firms engaged in making exportable products containing copper now find that for the time being it is almost impossible to obtain metal. It is unlikely that the position of these firms will become easier in the near future. The increasing demand of the war industries must, of course, receive first consideration and it is natural that the Control should hold copper against emergencies. In the United States the demand for national defence purposes is said to be tremendous, but at the same time it would appear that in some descriptions of civilian work the position is not so tight as it was feared would be the case. There have been no changes in price, the quotation for home trade being held at 12c. and for export at 11½c., although no business is heard of in the latter department. At the moment there seems sufficient copper available in the United States to meet the full demand for defence purposes. . . . The price of tin on the London market has fluctuated somewhat, but the world position would appear to be rather tight. Reports that the issue of export licences will be resumed do not appear to have any foundation, and the official attitude is that this is unlikely for some time. Expectations that the issue of licences would be recommenced caused a demand for cash tin, no doubt in the hope that export business would be resumed. Supplies in this country, however, are plentiful and large business is said to have been transacted with Russia, the tin going direct from the East. The United States are also taking good quantities of tin direct from the Straits and the Dutch East Indies and there is a section of the market which anticipates that American requirements plus supplies to Russia will create a rather tight position later on.

Lead and Spelter

With the markets, both in Great Britain and in the United States, under control there is no freedom in dealing. In Great Britain there is a huge demand for war purposes, and in the United States there is an equally heavy call to meet the requirements of the enormous American defence programme. Supplies of lead are also going to Russia from Empire countries, which may later on result in a more stringent position in this country. At present, however, supplies are ample to meet requirements, although the British Non-ferrous Metal Control is less inclined to release supplies for non-essential work. Consumption seems to have increased in some directions and is notably heavy in the case of the manufacturers of batteries and the cable makers. In the United States, although some fears are expressed of tightness developing later on, this does not appear likely to develop immediately. For the time being supplies are sufficient to meet the heavy Government demand, although the quantities released for civilian consumption have been cut down. . . . The position in the spelter market indicates a gradual tightening of supplies owing to extremely heavy demand for the war industries and other essential purposes. All the firms engaged in necessary work are receiving their full requirements, but it is not easy to obtain metal for ordinary civilian purposes. The brass manufacturers would appear, at the moment, to be the largest consumers, but there is an increasing demand for spelter from the die castings makers. The position in America has been rather stringent for some time and there is no indication that easier conditions will develop. In fact, the demand is extremely heavy and supplies are carefully allocated by the official control of that country. The recent increase in the United States domestic price to 8·25c. per pound, East St. Louis, has caused some discussion, but it seems to be generally considered that the producers were entitled to this advance in view of their increased costs.

NICKEL FROM VENEZUELA.—A recently organised firm of mining engineers has reported that it has acquired nickel-bearing properties near Lake Valencia. The ore is said to average 2 per cent. nickel.

Notes and Memoranda

Rail and Road

TROLLEYBUSES FOR SWITZERLAND.—Due to a shortage of petrol, the trolleybus is growing in favour in Switzerland, despite a shortage of the materials needed for the construction of new vehicles. At present trolleybuses are working in Zurich, Berne, Lausanne, Winterthur, Biel and Neuchatel.

HOW WAR AFFECTS TRANSPORT.—Figures which have been issued by the American Railway Institute show that loadings of revenue freight for a single week in October totalled 922,900 cars, an increase of 19,000 cars on the previous week and an increase of 109,000 cars on the corresponding week in 1939.

NEW SOUTH WALES AND HEAVY LOADS.—In order to deal with heavier war freights, the Railway Authority in New South Wales has relaxed certain regulations, and goods trains may now be assisted by pusher engines between Hawkesbury River and Cowan. In this way 1000-ton trains can now be run with two engines.

U.S.A. USING LONG WELDED RAILS.—Reference has been made in these columns to the use of continuous lengths of welded rails in the U.S.A. Recently the Illinois Central Railway has laid in a tunnel, sixteen 66ft. lengths of 112 lb. rails welded into sections 1056ft. long. These sections were then conveyed on flat cars to the tunnel, where they were welded together, making a continuous rail of more than 7000ft. in length through the tunnel.

PERSIA NEEDS LOCOMOTIVES AND RAILS.—Before much improvement in war transport in Persia can be effected, large quantities of rails will be required for construction work and for marshalling and other yards, as well as more locomotives and rolling stock. Unfortunately, India has no standard gauge stock such as is required for Persia. Egypt has locomotives and wagons of the required gauge, but the military demands upon these are already heavy. The British Government proposes to borrow some stock from Egypt and replace it with supplies from America. The standard gauge engines and rolling stock required can be got also from Australia and the United Kingdom.

VOLUNTEER BUS WORK.—Since the Birmingham City Transport Department inaugurated a scheme for voluntary tram and bus conductors to help the regular men or women conductors at peak hours, Leeds and other cities have adopted similar plans. The Liverpool Passenger Transport Department, for example, extended an invitation to regular passengers on trams and buses to help as auxiliary conductors during rush hours, and there has been a ready response. The Department proposes to issue a distinctive blue armlet and white metal badge. The volunteer will stand on the platform, and, while the conductor is otherwise engaged, will be responsible for operating the bell signal to the driver, for stopping and restarting the vehicle. The volunteer will also call out the names of stopping places, and, in return for performing these duties, will travel to his or her destination free of charge.

Air and Water

THE LIFEBOAT SERVICE.—Since the war began lifeboats of the Royal National Lifeboat Institution have rescued 4131 lives, exactly the same number that they rescued in the whole of the war of 1914–1918.

TUNNELLING A CANAL.—Plans are afoot to provide three bridges and a tunnel under the Panama Canal to replace the existing motor-car ferries which at present accommodate 90,000 cars monthly. The tunnel will be under the Pacific end of the canal.

THE SNOW-REMOVAL PROBLEM.—American and Canadian municipalities are paying special attention just now to the problem of removing snow, which if not promptly done might hold up war production. Our Canadian contemporary, *Roads and Bridges*, devoted almost the whole of the editorial pages in its September issue to ways and means of dealing with the matter.

THE ROEBLING CENTENARY.—American industry has been interested in the celebration of the one hundredth anniversary of the John A. Roebling's Sons Company, wire manufacturers. The founder, John A. Roebling, was a social pioneer, bridge-builder, inventor, manufacturer, and scientist. He sold his first wire rope in 1841 for a canal boat portage over the Allegheny Mountains. That first sale preceded by only six years Roebling's Monongahela River suspension bridge at Pittsburgh and the establishment of the present factory in Trenton, from which came the wire for such other famous Roebling enterprises as the bridges at Niagara, Brooklyn, and Cincinnati, as well as for the Hudson River crossing at New York and the Golden Gate span at San Francisco.

COMPLETION OF THE VALLECITO DAM:—The completion of a three million dollar dam on the Pine River, in South-Western Colorado, is reported. The reservoir created by the dam at its maximum storage level (7665ft. above sea level) has a surface area of 2723 acres, and at the minimum elevation (7582·5) to which the reservoir can be lowered it contains 4300 acre-feet of dead storage covering an area of 380 acres. It is the eightieth water storage reservoir created by the United States Bureau of Reclamation.

Miscellanea

INDIAN ANTIMONY.—Following research, several sources of antimony ore have recently been found in India, and it is expected that refining plant to work the ores will shortly be installed.

POLES, BUT NO CURRENT.—War priorities are keeping several thousand Indiana farmers from getting electric energy. Miles of poles have been erected during the past months, but there is insufficient wire to complete the work.

TIN TAILINGS TO BE SALVAGED.—Tin concentrates, now being produced at Kimberley, British Columbia, by the Consolidated Mining and Smelting Company of Canada, are being recovered in the form of cassiterite from "tailings" formerly regarded as waste.

THE INSTITUTE OF MARINE ENGINEERS.—The Right Hon. Lord Mottistone of Mottistone has accepted nomination by the Council of the Institute of Marine Engineers for election as President of the Institute for the year following the annual general meeting in March next.

UTILISING LOW-GRADE ORE.—The Montana Power Company has contracted to furnish power for a new works being opened by the Anaconda Copper Company. A 650-ton mill has already been built at the mine site, where a chromium deposit of low grade, but with almost limitless quantity, is said to be in sight.

REORGANISING A JAPANESE INDUSTRY.—The Japan Explosives Manufacturers' Industrial Associa ion has been organised to ensure a proper distribution of glycerine, ammonium nitrate, potassium nitrate, borax, and other materials needed in the manufacture of explosives. One factory is said to be manufacturing glycerine from waste molasses.

MOTOR-DRIVEN CAPSTAN LATHE.—In the article dealing with the Herbert No. 2D motor-driven capstan lathe in our issue of November 7th, it was stated that the ratio of the two speeds could be varied from 2½ to 1 for non-ferrous work, to ¼ to 1 for high-tensile steel; ¼ to 1 should read 10½ to 1. This ratio applies to the No. 2s machine, which was the forerunner of the No. 2D.

THE PYRITES TRADE OF SPAIN.—Recent official figures show an output of iron pyrites in Spain of 104,722 tons during January-April, 1941. Imports of pyrites into the U.S.A. from Spain during the first five months of 1941 amounted to 26,500 tons, representing only 30 per cent. of the total imports during the period. In 1940 Spain supplied 80 per cent. of the U.S. pyrites imports.

THE EFFICIENT USE OF COAL.—A research into the firing of small and medium-size boilers is to be undertaken by the British Coal Utilisation Research Association. The objects of the research are to widen the range of fuels which can satisfactorily be burned in these boilers and to determine the factors which control the maximum burning rate obtainable with any given type of coal and method of firing. Anyone interested in the research is invited to communicate with the Secretary of the Research Committee, Mr. H. G. Crone, at the British Coal Utilisation Research Association's Experimental Station, Rickett Street, Fulham, London, S.W.6.

Personal and Business

MR. F. SCOPES has been appointed deputy managing director of the Stanton Ironworks Company.

THE EARL OF CRAWFORD has been appointed Regional Fuel and Power Controller in the North-West Civil Defence Region.

SIR FRANKLIN SIBLY, D.Sc., LL.D., has been appointed by the Lord President of the Council to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. The Rt. Hon. the Viscount Falmouth has retired from the Council on completion of his term of office.

MR. P. PRITCHARD has been elected President of the British Cast Iron Research Association in succession to the late Lord Austin.

CAPTAIN G. L. BURNLEY JONES, Principal Officer of the Bristol Channel District of the Ministry of War Transport, has retired. His successor is Captain J. A. Theyer.

GEORGE COHEN, SONS AND CO., Ltd., of Wood Lane, London, have acquired the whole of the machinery and plant of the Beach Tin Operating Company (Gwythian), Ltd., near Hayle, Cornwall.

THE Executive Committee of the Association of Scientific Workers announces that Mr. R. A. Watson Watt, F.R.S., has become President of the Association. This office became vacant on the retirement of Professor F. G. Donnan, F.R.S.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of its insertion the necessary information should reach this office on or before the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Bradford Engineering Society

Monday, Nov. 24th.—Technical College, Bradford. "The Measurement of Surface Finish," C. Jolliffe. 7.15 p.m.

Institute of Transport

Tuesday, Nov. 25th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "Operating Problems After the War," C. F. Klapper. 1.15 p.m.

Institution of Automobile Engineers

Saturday, Nov. 22nd.—Engineers' Club, Albert Square, Manchester. "The Prevention of Accidents from the Technical Aspect," E. G. Beaumont. 3 p.m.

Institution of Civil Engineers

Satirday, Nov. 22nd.—YORKS. ASSOC.: Hotel Metropole, Leeds. Symposium on "Wartime Expedients." 2.30 p.m.

Institution of Electrical Engineers

To-day, Nov. 21st.—N. EASTERN STUDENTS: Neville Hall, Westgate Road, Newcastle-upon-Tyne. "Modern Electric Clocks," M. N. Karaosman. 6.30 p.m.

Saturday, Nov. 22nd.—N. MIDLAND STUDENTS: Visit to Odeon Cinema, The Headrow, Leeds. 2.30 p.m.

Monday, Nov. 24th.—N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-upon-Tyne. Informal discussion on Post-war Planning. 6.15 p.m.

Tuesday, Nov. 25th.—WIRELESS SECTION: Savoy Place, Victoria Embankment, W.C.2. "Tests for Radio Components, with Particular Reference to Ageing and Atmospheric Conditions," P. R. Coursey. 4 p.m.

Wednesday, Nov. 26th.—LONDON STUDENTS: Savoy Place, Victoria Embankment, W.C.2. "Electroplating," C. V. Taylor. 7 p.m.

Monday, Dec. 1st.—S. MIDLAND CENTRE: James Watt Institute, Birmingham. "The Characteristics and Performance in Service of High-voltage Porcelain Insulators," J. S. Forrest. 6 p.m.

Institution of Mechanical Engineers

To-day, Nov. 21st.—Storey's Gate, Westminster, S.W.1. Hawksley Lecture, "A Century of Tunnelling," W. T. Halcrow. 2.30 p.m.

Saturday, Nov. 22nd.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester. "Munitions Labour Supply Organisation," W. H. Denholm. 2.30 p.m.

Friday, Nov. 28th.—Storey's Gate, Westminster, S.W.1. "Practical Vibration Problems," H. L. Guy. 5.30 p.m.

Institution of Production Engineers

Saturday, Nov. 22nd.—EDINBURGH SECTION: North British Station Hotel, Edinburgh. "Electrical Deposition of Metals and the Anodic Treatment of Aluminium," S. Murray. 3 p.m.

Wednesday, Nov. 26th.—SHEFFIELD SECTION: Grand Hotel, Sheffield. "The Manufacture of Precision Measuring Tools," A. E. Morrison. 6.30 p.m.

Saturday, Nov. 29th.—MANCHESTER SECTION: College of Technology, Manchester. "Surface Finish," G. Schlesinger. 2.15 p.m.

Iron and Steel Institute

Tuesday, Nov. 25th.—4, Grosvenor Gardens, S.W.1. Autumn meeting. 2.45 p.m.

Junior Institution of Engineers

Saturday, Nov. 29th.—39, Victoria Street, S.W.1. "The Engineer and the Rest of the World: A Study in Relationships," K. S. Jewson. 2.30 p.m.

Keighley Association of Engineers

Friday, Nov. 28th.—Victoria Hotel, Keighley. "Impact and Notched Bar Testing," C. N. Waterhouse. 7 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Nov. 28th.—Literary and Philosophical Society, Newcastle-upon-Tyne. "Further Experiments with Models of Cargo-carrying Coasters," F. H. Todd and J. Weedon. 6 p.m.